Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

Volume No. 2

EXPLANATORY NOTES

for

DEPARTMENT OF AGRICULTURE

BUDGET ESTIMATES

Fiscal Year

1947

CONTENTS

	PAGES
Table of Contents	I
Agricultural Research Administration:	
Office of Administrator	[illegible]
Special Research Fund	13
Office of Experiment Stations	39
Bureau of Animal Industry	92
Bureau of Dairy Industry	147
Bureau of Plant Industry, Soils, and Agricultural Engineering	181
Bureau of Entomology and Plant Quarantine ...	278
Bureau of Agricultural and Industrial Chemistry	396
Bureau of Human Nutrition and Home Economics	462

LIBRARY
CURRENT SERIAL RECORD
JAN 1 1946
U.S. DEPARTMENT OF AGRICULTURE

AGRICULTURAL RESEARCH ADMINISTRATION
OFFICE OF ADMINISTRATOR

(a) Salaries and Expenses

Appropriation Act, 1946		$285,200
Anticipated supplemental for additional costs due to Federal Employees Pay Act of 1945		+40,000
Total anticipated available, 1946		325,200
Budget estimate, 1947		460,500
Change for 1947:		
Overtime decrease	-4,948	
Increases	+140,248	+135,300

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Administration and direction of the Agricultural Research Administration	$109,220	$134,600	$135,100	+$500 (1)
2. Supervision of maintenance, operation and furnishing of facilities and services at the Agricultural Research Center	163,025	185,652	325,400	+139,748 (2)
3. Overtime pay	37,102	4,948	- -	-4,948
Covered into Treasury as miscellaneous receipts, Public Law 529	34	- -	- -	- -
Unobligated balance	15,011	- -	- -	- -
Total available	324,392	325,200	460,500	+135,300
Anticipated supplemental	- -	-40,000	- -	
Total estimate or appropriation (1945 adjusted for comparability)	324,392	285,200	460,500	

INCREASES OR DECREASES

The net increase of $135,300 for 1947 consists of a $4,948 decrease for overtime, and the following:

(1) An increase of $500 under the project "Administration and direction of the Agricultural Research Administration" for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only part of the fiscal year 1946.

(2) An increase of $139,748 under the project "Supervision of maintenance operation, and furnishing of facilities and services at the Agricultural Research Center," composed of:

(a) An increase of $63,400 to provide improved water supply facilities:

Objective: To provide water of satisfactory quality for experimental purposes and for preventing the too rapid deterioration of lines and equipment.

A one-story brick building approximately 35 x 70 feet and 12 feet high would be constructed at an estimated cost of $15,000. This building would house treatment equipment for removing acidity, suspended material, and tastes. Construction of the building and water treatment facilities, and expansion and extension of mains and pumping facilities will be accomplished by force account unless it is determined to be more advantageous to contract with private concerns.

The Problem: The water supply of the Agricultural Research Center is obtained from wells on the property. The approximate daily consumption is 350,000 gallons. Based on 1939 Permutit and Warlo analysis reports and 1943 Maryland Department of Health analysis reports, the water at the Center has the following general objectionable characteristics:

Free carbon dioxide: Varies from 23 to 40 p.p.m. which is an undesirable amount because it is corrosive of itself, works with oxygen to produce corrosion, favors the growth of algae, reacts with water to form carbonic acid and causes water to become more corrosive, and causes a lowering of pH value (increase of H+ ion concentration, the H+ ion being a basic cause of corrosion).

Hydrogen ion concentration: pH values vary from 4.1 to 6.6 and average 5.4. This indicates an acid condition (neutral water having a pH of 7.0) which contributes both directly and indirectly toward the destruction of pipes, boiler tubes, plumbing fixtures, etc. The major cause of this low pH is the free carbon dioxide content of the water as explained above.

Bacteriological: During the calendar year 1943, the bacteriological examinations by the Maryland Department of Health showed the occurrence of bacteria of the coliform group in four of forty-six water samples examined. Additional data should be obtained before reaching definite conclusions but on the basis of present evidence two wells should be regarded with suspicion.

Iron: Reported iron content averages about 1.3 p.p.m. and varies from 0.0 to 28 p.p.m. In the majority of the analyses it is below 2 p.p.m. Presence of iron in quantities above 0.3 p.p.m. is objectionable due to its staining qualities and its effect on appearance. It is responsible for a noticeable taste in concentrations of 4.0 to 5.0 p.p.m. or greater.

Copper: Maryland Department of Health analyses indicate a copper content of 6.4 p.p.m. The Public Health Service standard is not exceeding 0.2 p.p.m.

The unsatisfactory quality of the water at the Center is detrimental to research work conducted there. A great deal of the work on vitamin content of foods and the effect of home cooking, canning, freezing, and drying on the nutritive value and palatability of food has been greatly complicated and always runs the danger of vitiation because of the high content of copper and other trace elements in the original water supply. Triple distillation of water is necessary for some types of work for which ordinary distilled water, or twice distilled water at most, should suffice. Furthermore, table tops and all equipment are so highly contaminated that special precautions must always be taken by workers who are doing quantitative studies, the results of which might be affected by trace elements.

Even for the first washing of foods to be analyzed for vitamins and minerals, distilled water must be used and for final washing and handling double distilled or sometimes triple distilled water must be employed. The flavor of delicate vegetables and meat is so affected that distilled water must be used in their preparation even if only palatability is to be the criteria for decisions.

The quality of the water interferes with research on textiles. The amount of copper in the water is so great that articles washed in it soon become discolored.

The free carbon dioxide and hydrogen ion concentration in the water supply causes rapid deterioration of water lines, pipes, boilers, and other equipment. Corrosion is greatest on primary and secondary steel and copper mains. Their normal life should be 15 years but because of corrosion they only last around 5 years. Return lines in the heating system of three laboratory buildings for research on poultry, for example, had to be replaced in 5 years at a cost of approximately $975 for each building. Repairs and renewal of a refrigerator condenser and connecting lines for Bureau of Dairy Industry work at a cost of approximately $1,800 were necessary due to action of the water after 5 years of service.

Water treatment facilities are needed to correct the objectionable characteristics of the water supply. Such facilities and improved pumping facilities would make it possible to use the water from a larger number of wells and thereby provide a reserve supply of water in case of need.

(b) An increase of $16,400 to provide fire escapes on laboratory buildings at the Center:

Objective: To protect human life in case of fire by erecting two fire escapes on each of four laboratory buildings.

A fire escape of the common stair type is planned for each end of the four buildings, and is to be fabricated and erected by the Center Mechanical Shop unless it is determined to be more economical to contract with private concerns.

The Problem: The four laboratory buildings comprising the principal group at the Center each have one stair well and elevator in the center of each building. These provide the only exits in case of fire. A fire in the center part of the building blocking these exits would leave no means of escape for employees except jumping from windows. Construction of suitable fire escapes is urgently needed to protect human life in case of fire.

(c) An increase of $5,100 for a central guard station at the Center:

Objective: To protect Government property by maintaining a central guard headquarters and 24-hour telephone service at the Agricultural Research Center.

Guards and patrol mechanics, making regular rounds, would report each hour to the Central station, and in case of fire, disruption of power service, variation of constant temperature in certain rooms or in any other emergency requiring attention, the central station would be notified and the information transmitted to the proper authority.

The Need: Due to the distance between laboratories, experimental animal buildings and pens, and other facilities scattered over the 12,000 acres of the Agricultural Research Center, 24-hour telephone service functioning as a central guard station should be maintained for clearing information on fires, accidents and other hazards affecting the proper functioning and safety of laboratories, animals, and other facilities and equipment in which there is a large public investment.

For the past few years the Center has received funds from the Public Buildings Administration to provide a switchboard operator between the hours of 4 p.m. and 8 a.m. daily. This fund which was made available for protection of Government property during the war, will not be received for the fiscal year 1947. The proposed increase would provide for continuation of this 24-hour telephone service.

Before such service was maintained a guard died on duty at night and the fact was not discovered until the next morning. A central station for the guards to report to is necessary to disclose such situations. Prompt knowledge of the illness of a guard on duty may result in saving a life as well as provide for continuous protection of Government property.

(d) An increase of $21,500 for construction of approximately 3/4 mile of bituminous road to provide a short cut to Greenbelt, Md.:

Objective: To facilitate transportation of employees to the Agricultural Research Center and provide better fire protection by more direct access to Greenbelt, Md.

The road would be approximately three-quarters of a mile long and twenty feet wide. The estimate includes clearing, grading, ditching, side sloping, construction of stabilized gravel base course and bituminous surface. Material would be purchased by contract and the work done by the Center.

The Problem and its Significance: Approximately 125 employees of the Research Center live in the town of Greenbelt, Md., and it is expected that many more of our employees will reside in Greenbelt in the next few years. These employees must travel a roundabout way to reach the Research Center, and there is no public transportation available. The present route to the residential area of Greenbelt is ten and one-half miles round trip. By constructing approximately three-quarters of a mile of road on the Center land to connect with an existing road in Greenbelt, this distance can be shortened to approximately four miles round trip, or a daily saving of six and one-half miles driving per car. It is also possible that by constructing this road the Capital Transit Company could be induced to extend public transportation to the Research Center.

This road would also provide access to areas of the Research Center now inaccessible by road, and provide better fire protection. To a certain extent local fire companies are depended upon for fire protection. Since Greenbelt is the closest town with adequate fire-fighting equipment, this shortening of the distance to Greenbelt would aid materially in case of fire.

(e) An increase of $32,360 for fencing to mark boundaries and protect Government property:

Objective: Through surveys, to determine boundaries of the Agricultural Research Center where necessary and to erect fences to mark the boundaries and protect Government property, including experimental animals.

The Problem: The boundaries of the Center are not definite in some areas, particularly between the Center and Greenbelt. Surveys are needed in such cases to determine the exact boundaries.

Fences are needed to mark the boundaries once they are determined and to protect property, particularly experimental animals. Nearly 100 head of valuable sheep and many chickens and turkeys are killed yearly by prowling dogs, and young boys from nearby communities are a continual nuisance, chasing animals and stealing and damaging property.

There are 10 to 12 miles of boundary which should be fenced. The increase for 1947 would provide for boundary surveys and erection of chain link fencing on approximately 14,000 feet (2.65 miles) of the boundary between the Center and Greenbelt.

The work would be performed by force account unless it is determined that it can be accomplished more economically by contract with private firms.

(f) An increase of $988 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

CHANGES IN LANGUATE

The estimates include proposed changes in the language of this item as follows (new language underscored, deleted matter enclosed with brackets):

Change No.	
	Salaries and expenses: For necessary salaries and expenses of the Office of Administrator, including the salary of the
1	Administrator at [$9,200] $10,000 per annum, and personal services in the District of Columbia and elsewhere, and for necessary expenses in connection with the maintenance, operation, and furnishing of facilities and services at the Agri-
2	cultural Research Center, [$285,200] including not to exceed $15,000 for the construction of a building to house water treatment facilities at the Center, $460,500: * * *.

The first change in language relates to the amount of salary for the Research Administrator. The salary of the Research Administrator, which in 1946 is specifically appropriated for at the annual rate of $9,200 in the Agricultural Appropriation Act (for which authority is contained in 5 U.S.C. 673), was increased to $10,000 in accordance with the provisions of Sections 602(b) and 603(b) of the Federal Employees Pay Act of 1945, approved June 30, 1945 (Public Law 106). Accordingly, the Research Administrator is receiving a salary at the rate of $10,000 in 1946 and, therefore, the proposed language change will merely continue his present rate of compensation and will not result in an increase in compensation in 1947.

The second change in language provides authority for the use of not to exceed $15,000 in 1947 for the construction of a building at the Agricultural Research Center. The estimates include an increase of $63,400 to provide facilities to assure water of satisfactory quality for experimental purposes and for preventing the too rapid deterioration of pipe lines and equipment. The building is needed to house the treatment equipment for removing acidity, suspended material and tastes. The requested authority for the construction of the building is in accordance with the Department of Agriculture Organic Act of 1944 (5 U.S.C. 565a).

WORK UNDER THIS APPROPRIATION

The Office of Administrator, Agricultural Research Administration provides for direction and supervision of the Administration which comprises the Bureau of Animal Industry; Bureau of Dairy Industry; Bureau of Plant Industry, Soils, and Agricultural Engineering; Bureau of Entomology and Plant Quarantine; Bureau of Agricultural and Industrial Chemistry; Bureau of Human Nutrition and Home Economics; and Office of Experiment Stations. The Administrator is also responsible for general administration of the Special Research Fund and general supervision of the Agricultural Research Center.

Functions: The Office of Administrator plans, develops, coordinates, and directs the scientific research program of the Agricultural Research Administration to assure the most effective utilization of personnel and facilities; relates the Department's research program with those going forward in private industry and in other Governmental agencies; and determines research objectives in the light of changing needs of agriculture and of the Nation for foods and fiber.

Examples of Activities:

Administration and Direction of the Agricultural Research Administration: The Office of Administrator, to assure integration and coordination of all phases of the research of the Administration, carefully considers each proposed individual research project, each budget estimate, and each proposed memorandum of understanding and cooperative agreement covering cooperative research with State agricultural experiment stations or other agencies. Approval of the Office of Administrator is required on all such undertakings and proposals.

As a further effort to integrate and render more effective the research program the following procedure is being developed within the Administration:

(1) Joint consideration of problems confronted or as they may be anticipated. This consideration is on a plane irrespective of agency functions: It is directed to an objective analysis with a view of developing (a) common understanding of the factors involved, (b) areas of interest not covered by current research (c) the need for additional research, if any, and (d) the procedures required in a full-rounded program.

(2) Determination of agency responsibility in furthering the program developed by joint consideration of problems.

(3) Formulation of revised or new project outlines by the responsible agencies, and the submission of those outlines for review and integration in conformity with the research program.

(4) Formulation and submission of budget estimates, as required in order better to support current research or to obtain necessary support for the additional research deemed advisable.

In this procedure, there is recognition of the need for consultation with the Directors of State Agricultural Experiment Stations, through their Committee on Organization and Policy, or by regional or lesser groups, in order to effect the closest possible integration, the maximum effectiveness, and a minimum of over-lapping.

This is a large undertaking that will take much time fully to accomplish, but a beginning has been made and, as the procedure is clarified and better understood by all agencies concerned, progress should become proportionately rapid.

Because of the importance of vitamins, both in animal feeds and in human food, and the necessity for vitamin determinations in carrying out the research of most of the Agricultural Research Administration bureaus, a study was made of the methods used for vitamin determinations by the different bureaus. The results of the study made available to the bureaus the experience each had gained in the use of various methods. An inventory of special equipment for vitamin determinations and its location in the different bureaus was furnished to further facilitate research involving vitamin determinations and to avoid unnecessary duplication of research equipment.

For use by the delegates of the Third Inter-American Agricultural Conference at Caracas, Venezuela, July 24 to August 7, 1945, the Office of Administrator was responsible for leadership in: the preparation and assembly of summary statements by specialists of the Administration relative to various phases of American agriculture, together with complete references to pertinent literature, and abstracts of an extensive list of important scientific papers; assembly of a bibliography of approximately 1,800 titles of up-to-date literature dealing with all phases of American agriculture; and assembly and shipment to Caracas of various research publications of the Department and the State agricultural experiment stations.

Supervision of maintenance, operation, and furnishing of facilities and services at the Agricultural Research Center: The facilities maintained include fire protection, sewage disposal, mail and messenger service, emergency and first aid infirmary service, road maintenance, inspection of buildings for fire hazards and general safety of operations, upkeep and maintenance of grounds adjacent to 3 laboratory buildings, guard service for these buildings and night road patrol. Supervision is provided for facilities for work performed on a reimbursable basis. These facilities include electrical distribution, water distribution, central heating plant, telephone switchboard, granary, coal handling, building maintenance, mechanical shops, and farm operations.

An increased road maintenance program was effected in the fiscal year 1945: 29.5 miles of road with an average of 20-foot width, or 346,079 square yards, was maintained; 76,120 square yards were retreated and 12,860 square yards were given an initial surface treatment; 17,614 lineal feet of shoulders were trimmed; 519 lineal feet of ditches were cleaned; and 1,106 lineal feet of concrete crub and gutter were installed. There were 1,450 square yards of plant-mixed patching and 7,200 square yards of skin patching. The maintenance operations required 2,985 tons of bank gravel and 42,650 gallons of bituminous material.

The sewage disposal plant capacity was increased with a new pump pit and installation of two 200-gallon per minute pumps. During the fiscal year 1945, the plant disposed of approximately 133,060,000 gallons of sewage.

Reimbursable work performed by the Center during the fiscal year 1945 amounted to approximately $935,000. In this connection, 7,230,000 kilowatt hours of electrical energy were purchased and distributed over the Center-owned lines. The electrical distribution system was increased by 13,880 feet of single phase 2,400 volt line; 5,600 feet of 3 phase, 4 wire, 4,400 volt line; 3,000 feet of 208 volt secondary line; and eight 5KVA 2,400 volt single phase transformers. 127,000,000 gallons of water were supplied from the Center's water system. Process steam supplied to laboratories amounted to 11,483,000 pounds and the heating load required 58,296,000 pounds of steam. The mechanical shops received and completed over 4,000 requests for service.

The granary purchased and processed 3,214 tons of livestock and poultry feed. The coal-handling facilities distributed 19,590 tons of coal. The farm section, as required by the research bureaus, supplied labor, materials, and equipment needed in facilitating the farm and field work of the bureaus.

(b) Special Research Fund, Department of Agriculture (Allotment to Office of Administrator)

This budget schedule covers obligations under an allotment for the Special Research Fund laboratory to conduct research into the relation of soils to plant, animal, and human nutrition, a project which is placed under the direct supervision of the Agricultural Research Administrator, since the subject matter is not exclusively within the functions of any one constituent Bureau.

(c) Working Funds (Office of Administrator)

This budget schedule covers obligations under advances to the Office of Administrator, pursuant to section 601 of the Economy Act of June 30, 1932, for services performed for agencies as indicated in the following statement of obligations under supplemental funds.

STATEMENT OF OBLIGATIONS UNDER SUPPLEMENTAL FUNDS
[1945 and 1946 figures include overtime costs]

Item	Obligations, 1945	Estimated obligations, 1946	Estimated obligations, 1947
Special Research Fund, Department of Agriculture: For laboratory for research into relation of soils to plant, animal and human nutrition	$104,627	$107,540	$106,193
Working Funds, (Office of Administrator, Agricultural Research Administration) Advances from:			
War Production Board: For directing and coordinating investigations in food compression, packaging of dehydrated compressed food products, and related studies	1,365	- -	- -
Public Buildings Administration: Emergency guards at the central guard office, Agricultural Research Center	4,582	1,392	- -
War Department: Liming, fertilizing, seeding and mulching required to restore approximately 500 acres at the Agricultural Research Center used by War Department as an airport	- -	16,000	- -
Total, Working Funds	5,947	17,392	- -
Total, Obligations under supplemental funds	110,574	124,932	106,193

PASSENGER-CARRYING VEHICLES

The estimate for the purchase of passenger-carrying vehicles for the Office of Administrator, Agricultural Research Administration, contemplates a decrease of $50 ($750 in 1947, and $800 in 1946) in expenditures for this purpose. The total estimated expenditure of $3,000 will permit (1) the operation and maintenance of 10 vehicles and (2) the replacement of 1 vehicle, or approximately 10% of the total number in use, at a net cost of $750 when the estimated exchange allowance is taken into account. No funds are requested for the purchase of additional vehicles.

The cars involved are necessary for the conduct of operations at the Agricultural Research Center which covers an area of 11,700 acres.

The vehicle to be exchanged is ten years old and has been driven more than 62,000 miles. The car replacing it will be used by the Superintendent, Office of Operations, in supervising the maintenance and operations of the Agricultural Research Center.

PENALTY MAIL ESTIMATE
Sec. 2, Public Law 364, 78th Congress
(Allotment to Office of Administrator,
Agricultural Research Administration)

	1945	1946	1947	Increase (+) or decrease (-), 1947 over 1946
Category 1	$15	$15	$15	$ - -
Category 2	380	369	369	- -
Total	395	384	384	- -

Category 1 consists of bulletins and circulars reporting the results of research mailed in response to requests for information on research problems which are received by the Office of Administrator.

Category 2 consists of administrative correspondence necessary for (a) carrying on the work of the Office of Administrator, involving the administration and direction of the Agricultural Research Administration which comprises the Bureau of Animal Industry; Bureau of Dairy Industry; Bureau of Plant Industry, Soils, and Agricultural Engineering; Bureau of Entomology and Plant Quarantine; Bureau of Agricultural and Industrial Chemistry; Bureau of Human Nutrition and Home Economics; and the Office of Experiment Stations; (b) conducting administrative operations at the Agricultural Research Center, particularly the mailing of business documents, such as purchase orders, contracts, and vouchers, in connection with the services and supply activities performed by the Center; and (c) conducting the research program of the Plant, Soil, and Nutrition Laboratory at Ithaca, New York.

SPECIAL RESEARCH FUND, DEPARTMENT OF AGRICULTURE

Appropriation Act, 1946	$1,088,000
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945	+120,000
Total anticipated available, 1946	1,208,000
Budget estimate, 1947	1,193,000
Change for 1947:	
Overtime decrease -17,921	
Increase +2,921	-15,000

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Special research laboratories in major agricultural regions	$654,932	$721,682	$723,126	+$1,444
2. Special research projects	398,558	444,704	446,181	+1,477
3. Administration of payments to States, under Title I, Bankhead-Jones Act	20,073	23,693	23,693	- -
4. Overtime pay	126,063	17,921	- -	-17,921
Covered into Treasury as miscellaneous receipts, Public Law 529	77	- -	- -	- -
Unobligated balance	26,661	- -	- -	- -
Total available	1,226,364	1,208,000	1,193,000	-15,000 (1)
Anticipated supplemental	- -	-120,000	- -	
Total estimate or appropriation	1,226,364	1,088,000	1,193,000	

INCREASES OR DECREASES

(1) The net decrease of $15,000 for 1947 consists of the $17,921 decrease for overtime and an increase of $2,921 (for the projects indicated) for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

WORK UNDER THIS APPROPRIATION

General: Section 4, Title I, of the Bankhead-Jones Act (approved June 29, 1935) provides that 40 percent of the fund appropriated in any one fiscal year pursuant to that Title shall constitute the "Special research fund, Department of Agriculture," and shall be available for (a) the establishment and maintenance of research laboratories and facilities in major agricultural regions of the United States and the prosecution of research at such laboratories; (b) special research projects approved by the Secretary of Agriculture and conducted by such agencies of the Department of Agriculture as the Secretary may designate or establish; and (c) administration of the provisions of the Act authorizing payments to States, Hawaii, Alaska, and Puerto Rico for research to be conducted by agricultural experiment stations. Section 1 of the Act specifies that the work conducted under the Special Research Fund shall be "research into laws and principles underlying basic problems of agriculture in its broadest aspects; research relating to the improvement of the quality of, and the development of new and improved methods of production of, distribution of, and new and extended uses and markets for, agricultural commodities and byproducts and manufactures thereof; and research relating to the conservation, development, and use of land and water resources for agricultural purposes."

The actual and estimated appropriations and the authorized appropriations under Title I of the Bankhead-Jones Act for the Special Research Fund since its establishment are as follows:

Fiscal year	Appropriated				Total authorized
	Regional laboratories	Special research projects	Administration of Bankhead-Jones payments to States	Total	
1936	$ 200,000	$ 192,000	$ 8,000	$ 400,000	$ 400,000
1937	400,000	384,000	16,000	800,000	800,000
1938	600,000	576,000	24,000	1,200,000	1,200,000
1939	700,000	672,000	28,000	1,400,000	1,600,000
1940	700,000	672,000	28,000	1,400,000	2,000,000
1941	700,000	672,000	28,000	1,400,000	2,000,000
1942	701,528	480,003	24,769	1,206,300	2,000,000
1943	700,000	427,000	23,000	1,150,000	2,000,000
1944	733,100	456,045	22,941	a/1,212,086	2,000,000
1945	742,315	461,108	22,941	b/1,226,364	2,000,000
*1946	721,682	444,704	23,693	c/1,208,000	2,000,000
*1947	723,126	446,181	23,693	1,193,000	2,000,000

* Estimated

a/ Includes $65,000 appropriated in the First Supplemental Appropriation Act, 1944, for overtime.

b/ Excludes $23,473 transferred in 1945 Appropriation Act to "Salaries and expenses, Office of Administrator, Agricultural Research Administration."

c/ Includes $120,000 estimated additional funds required pursuant to Federal Employees' Pay Act of 1945 (Public Law 106).

The amount authorized, according to the terms of the Act, is distributed on the basis of 50 per cent for regional laboratories, 48 per cent for special research projects, and 2 per cent for the administration of Bankhead-Jones payments to States. This percentage distribution was followed in the appropriations until the fiscal year 1942 when the appropriation for the Special Research Fund was reduced; however, none of the reduction was applied to the amount for regional laboratories. Since that time the amount for regional laboratories has been specifically stated in the appropriation act.

Special Research Laboratories in Major Agricultural Regions:

Nine regional laboratories have been established under the provisions of Sections 1 and 4 of the Bankhead-Jones Act of June 29, 1935, to provide a joint Department and State experiment station attack on problems of regional or national scope. These regional laboratories, which were established and are conducted in each case with the cooperation and participation of the State agricultural experiment stations in the respective regions, serve as focal centers for regional coordination and cooperation on research in the subjects under study by the laboratories. The work of the laboratories is centered especially upon phases of the problem under study which would be difficult or impossible for an individual State or a group of States to undertake.

(Continued on next page)

The allotments made to Special Research Fund Regional Laboratories for the fiscal year 1945 and the estimated allotments for the fiscal years 1946 and 1947, are as follows:

Laboratory	Location	Allotment, 1945	Estimated allotment, 1946	Estimated allotment, 1947
1. Regional Vegetable Breeding Laboratory	Charleston, S. C.	$ 66,254	$ 69,997	$ 69,997
2. Regional Pasture Research Laboratory	State College, Pa.	57,839	62,820	62,820
3. Regional Soybean Laboratory.....	Urbana, Ill.	81,801	88,460	88,460
4, Regional Swine Breeding Laboratory	Ames, Iowa	59,806	64,492	64,622
5. Regional Sheep Breeding Laboratory	Dubois, Idaho	55,730	60,434	60,737
6. Regional Animal Disease Laboratory	Auburn, Ala	68,460	66,124	66,118
7. Regional Laboratory for Improvement of Viability in Poultry.....	East Lansing, Mich.	99,713	109,470	110,049
8. Regional Salinity Laboratory.....	Riverside, Calif.	84,316	94,130	94,130
9. Regional Laboratory for Research into the Relation of Soils to Plant, Animal, and Human Nutrition.....	Ithaca, N. Y.	95,227	105,755	106,193
10. Overtime pay.....		73,169	10,495	--
Total available ..		742,315	732,177	723,126
Excess of obligations over appropriation due to Public Law 106..		--	- 69,283	--
Total appropriation or estimate, Special Research Fund Regional Laboratories ...		742,315	662,894	723,126

Examples of progress and current program: The following are examples of the progress made and work conducted at each of the laboratories during the fiscal year 1945:

Regional Vegetable Breeding Laboratory: (Approved by the Secretary, November 30, 1935; located at Charleston, South Carolina).

General Objective: The primary purpose of the laboratory is the development of principles and methods of breeding, the determining of methods of inheritance of specific characters, the finding and use of superior germ plasm, the production of promising breeding stocks to be used in producing new varieties of vegetables that will be resistant to diseases and insects, to adverse temperatures and that will be of high quality and great yielding ability in the Southeast. These basic principles and materials are to be further used or applied in practical breeding by the cooperating States and others. From its breeding stocks the laboratory in addition develops new, improved varieties of vegetables for the Southeast. Currently the program includes work on tomatoes, sweet corn, peas, beans, watermelons, and cabbage. Preliminary studies are in progress on lima beans and carrots which will form the basis for later more extensive studies.

The laboratory is credited with the first publication in any language on the genetics of vitamin content of a horticultural crop. Through studies on the inheritance of ascorbic acid (vitamin C) in snap beans, the laboratory has demonstrated that the progeny of certain crosses have a much higher ascorbic acid content than either parent. This fact offers possibilities for developing new varieties with higher ascorbic acid values.

The Wando pea variety developed by the laboratory was shown by tests to have great possibilities for commercial freezing. In tests, which were conducted by the Western Regional Research Laboratory in cooperation with the Utah and Washington Agricultural Experiment Stations, the Wando variety was superior to all others in yield, skin texture, flavor, and color. Wando was developed by the U. S. Regional Vegetable Breeding Laboratory and released for trials and to seedsmen a few years ago as a cold-tolerant variety. Under Charleston, S. C., conditions (usually considered unfavorable for peas) the yields of Wando compare favorably with pea yields obtained in the major pea-processing areas of the country. Favorable reports on yield and quality have been received from other of the Southeastern States.

Three ear-worm-resistant top-cross sweet corn hybrids developed by the laboratory compare favorably with the commercial variety Golden Cross Bantam in quality and yield. The niacin (pellagra-preventive vitamin) content of four locally produced sweet corn strains has been found to be significantly higher than that of Golden Cross Bantam. Included in these four strains are White Kiawah and Wapnoo, two varieties released by the laboratory last year.

Definite progress has been made in combining wilt resistance and anthracnose resistance in watermelons with high quality and with "tough" or "slippery" type rind.

Regional Pasture Research Laboratory: (Approved by the Secretary, February 20, 1936; located at State College, Pennsylvania).

General Objective: The Northeastern Region is an important source of milk for the centers of population along the eastern seaboard. Milk is important to human health, and the supply of milk and products made from it are inadequate to meet all the demands. Perhaps the greatest single limiting factor in milk production is inadequate nutritious forage throughout the grazing season. The pasture improvement program of the laboratory was established to increase the productiveness of pasture during the entire grazing season and to provide surpluses in the form of grass silage or hay to be used as roughage for cows during periods when pasture is not available. These objectives, through effective cooperation of the twelve northeastern States, are being achieved by the development of improved techniques and principles of breeding, improved strains of pasture plants, and better pasture management practices.

As a result of pasture management experiments, particularly on pasture renovation, (conducted by the laboratory in cooperation with the Northeastern Agricultural Experiment Stations) improved practices are being advocated by extension agronomists and accepted on farms in the region. Methods of establishment and management of the larger-growing grasses and legumes not only on unproductive pasture land but on productive crop land as well have been developed to the point where they are becoming adopted as practical procedures on farms. During the year a further expansion of the pasture management studies was initiated in cooperation with the Pennsylvania Agricultural Experiment Station by setting up experiments to study how best to manage orchard grass and Ladino clover pastures for dairy cows and for turkeys.

Pasture production in the region could be greatly increased through nitrogen fertilization. In many cases, however, the luxuriant growth of grass following nitrogen fertilization crowds out much of the clover, and the yields decline unless nitrogen applications are made at frequent intervals. Studies during the past year suggest that nitrogen fertilizer may be used to give increased production of grass-clover pastures early in the spring when clover grows less vigorously than Kentucky bluegrass and yet a satisfactory stand of clover may be maintained if the pasture is properly managed.

Encouraging progress is being made experimentally in the production of hybrid seed in orchard grass. The production of hybrid seed of the forage grasses for commercial use is limited by the fact that both male and female parts are borne in the same flower. Hence, removal of the male flower parts from plants of the female parent, accomplished by detasseling in corn, is not feasible. It may be possible, however, to accomplish the same purpose in orchard grass by use of a type of male sterility that has been discovered. When male sterile plants of this type are crossed with appropriate male fertile lines, the resulting single cross plants are all male sterile, i.e., they do not produce pollen. Such single crosses can be used for producing double cross seed without the necessity of detasseling. This development holds promise of applying to pasture grasses the breeding principle which has been so successful in increasing corn yields through the use of hybrid seed.

At the request of the Editor of Botanical Review, all the published literature dealing with the cytology and genetics of forage grasses has been reviewed, interpreted, and prepared for publication. This review paper, which summarizes results presented in more than 600 research papers, will serve as a compendium of information for all research workers dealing with improvements by breeding of the forage grasses.

Meadow fescue plants highly resistant, if not immune, to crown rust have been discovered. Repeated inoculations under controlled greenhouse conditions have failed to induce crown rust on the most resistant plants. Since crown rust is one of the most common and destructive of diseases affecting meadow fescue, this new stock has great potential value for improving this crop.

Alfalfa and clover seed may be treated with fungicides to kill surface-borne diseases and stored for more than a year without lowering germination of the seed. This finding should be important in preventing the introduction of destructive diseases by seeds shipped into areas where the diseases do not already exist.

Regional Soybean Laboratory: (Approved by the Secretary, February 20, 1936; located at Urbana, Illinois).

General Objective: Soybean production increased from 23,095,000 bushels in 1934 to 192,863,000 bushels in 1944. The crop's estimated value to the growers for beans, forage, pasture, and soil improvement is over one-half billion dollars, and soybean processing is now a 400 million dollar-a-year industry. The need for protein and oil for food, feed, and other industrial purposes has made the soybean of vital importance in the present emergency. The rapid expansion of this crop into new areas has made it necessary to develop new strains or varieties adapted to varying environments. Such varieties must produce satisfactorily, and have high oil content of desirable quality.

Six States of the North Central Region in 1945 have planted over 450,000 acres of the variety Lincoln released by the laboratory three years ago. This acreage should result in a production of over 8 million bushels of seed, an ample supply to meet all 1946 seed requirements and leave some for processing. The variety has continued to yield more than 4 bushels per acre higher than the commonly grown varieties in its area of adaptation and has also continued to be the highest in oil content; it is, likewise, resistant to lodging and is generally satisfactory in other agronomic characteristics. Cooperative planning in the region has provided a more even distribution of high quality seed throughout the area where it is adapted, thus making the variety more rapidly available to producers.

During the past year a new early soybean variety "Flambeau" has been named and increased for release. This strain has been tested for two years in the Uniform Cooperative Soybean Nurseries and for several years previously by the Wisconsin Agricultural Experiment Station at Spooner, Wisconsin, where it was developed in cooperation with the laboratory. It has averaged ten days earlier than Mandarin, the most commonly grown early variety, and has yielded better than any other

strain in its maturity class. Flambeau has also averaged higher in oil content than other varieties of similar maturity. The development and release of this new strain will mean more profitable soybean production in Northern Minnesota, North Dakota, Northern Wisconsin, and probably in other sections of the northern states where a very early maturing variety is desired. Seed of this strain is being increased in Wisconsin and limited quantities should be available to farmers in 1946.

Increased yields and better weed control may be expected from May 15 planting than from April 15 planting, under conditions frequently encountered in the South, according to cooperative date-of-planting studies conducted by the laboratory. These later seedings of the improved adapted southern varieties now being increased and distributed to farmers will result in materially improved quality of seed for industrial use.

The variety Ogden has been increased during the last two years to the extent that seed is generally available for use in the upper south, the area where it has been found by extensive testing to be well adapted. Through the work of the laboratory, Ogden has been found to be lodging-resistant and higher in oil content than other strains commonly grown in that area.

An extensive soybean disease survey has been conducted whereby the most widespread and potentially destructive diseases have been singled out for intensive study in regard to control measures. The soybean diseases, wildfire and brown stem rot, are being studied currently. Uniform testing of chemical seed treatments in 18 cooperating states has given no indication that seed treatment offers any promise of practical disease control. The process by which leaves become infected with bacteria in the development of bacterial leaf spots has been critically studied with the result that new concepts have been developed regarding the method of infection in all crops, particularly soybeans. This has enabled pathologists to test varieties for disease resistance in the field and obtain reliable evaluations of them. One variety, Clemson Non-shatter, thought earlier to be resistant to bacterial pustule, has weathered these critical tests and is now recognized as resistant. This variety will now be used as breeding material in the development of new resistant strains.

Prompt harvesting and proper storage of soybean seed to prevent weather damage is important in producing high quality oil. Chemical studies at the laboratory have indicated that good seed quality is important in producing good soybean oil. Badly weather-damaged seed has been shown to have a free fatty acid content several times as high as sound seed. This results in a severe loss in quantity as well as in quality of the oil. Badly weather-damaged seed suffers in some seasons a loss in dry weight amounting to as much as 25 percent.

Regional Swine Breeding Laboratory: (Approved by the Secretary, December 22, 1936; located at Ames, Iowa).

General Objective: There has been relatively little improvement in the economic characters of swine nor in the development of improved swine breeding methods during the past several decades. In light of the fact that swine produce approximately one-half of the total tonnage of meat of the Nation the lack of attention to this phase of swine production has been a serious handicap to the swine industry. The laboratory is attempting, through research, to explore the possibilities for applying the science of breeding, including recently discovered techniques, to speed the improvement of swine. The laboratory program was planned to discover, develop, and test procedures of breeding that may be used by hog producers in improving productiveness of sows, growth rate of pigs, economy of gains, vitality of pigs, and desirability of carcasses.

The first procedure explored was to test the application to hog breeding of the principles that have been used successfully with corn. This procedure seemed to be sound as it offered opportunity not only for testing the usefulness of inbred lines for crossing to produce market hogs but also for speeding improvement in the "seed stock value" of purebred hogs. The initial step in the program was to form inbred lines, using five breeds - Poland China, Duroc Jersey, Hampshire, Chester White, and Danish-Landrace - and three crossbreed foundations - Landrace x Tamworth, Yorkshire x Poland China, and (Landrace - Tamworth) x Duroc Jersey. A total of 56 lines have been started, but 14 of these have been dropped because of poor performance, or are being converged to form new lines.

Trials for testing the performance of inbred lines in topcrosses, single crosses, triple line crosses, and breed crosses are being continued. Approximately 800 litters were produced in 1944 at the following co-operating stations in the North Central region: Illinois, Indiana, Iowa, Minnesota, Missouri, Nebraska, Oklahoma and Wisconsin. Approximately 600 inbred boars from the various projects have been released to farmers for use in topcrosses. A few trials have been conducted with inbred boars in topcrosses at the stations. Reports from farmers and results obtained at stations indicate that the use of boars from good inbred lines on noninbred sows may result in a little increase, about 2 or 3 percent, in the weight of litters at weaning age and about 7 percent more weight per litter (approximately 100 pounds) when the pigs are 6 months old, as compared to litters by noninbred purebred boars. Such crosses have also given some increase in viability as measured by the number of pigs weaned per litter.

Trials completed during the year with triple line crosses have given encouraging results from two points of view: (1) as a means of improving the breeding value of purebred hogs, and (2) as a means of improving the performance of both purebred and crossbred hogs for the production of market hogs. Single line cross sows mated to an inbred boar of a third inbred line have produced pigs that equal or exceed litters of purebred noninbred stock in number of pigs farrowed, more of the pigs born survive and they show an appreciable increase in rate of growth to market weight. Data available suggest that for good inbred lines, triple cross litters may be expected to weigh about

300 pounds more per litter at 6 months than pure breds not inbred, if they are fed for maximum performance. The increase is due to more pigs per litter and to increased rate of growth of the pigs. Survival of pigs seemingly is one of the most important factors in respect to economic production.

Only a few double line crosses have been tried. The results suggest that these may exceed triple line crosses in performance but the results are not yet conclusive.

Results achieved with lines from crossbred foundations have shown that a breed or line may be improved quickly by crossing to one superior in the characters in which improvement is desired. Apparently a new line or a new breed can be formed much more rapidly from crossbred stock than is believed generally.

Carcasses of hogs from the various inbred lines studied in packing plants have been satisfactory to packer graders. These carcasses have yielded a higher percentage of the primal cuts (ham, loin, shoulder butt and picnics) and less fat than the average of the "packers kill" for hogs of similar weight. This change in carcass quality may be extremely important when lard must again compete with other shortenings.

Regional Sheep Breeding Laboratory: (Approved by the Secretary, February 24, 1937; located at Dubois, Idaho).

General Objective: The twelve western States have approximately two-thirds of all the breeding sheep in the United States. This population of sheep produces approximately 275 million pounds of wool annually and supplies about 65 percent of the lamb used by the consuming public. In producing this essential wool and meat, sheep utilize a large proportion of the vast areas of the region that are suited only for grazing. Certain of these areas are not adapted to other kinds of range livestock. Utilization of these grazing areas to best advantage necessitates the development of specialized sheep for the type of environment which the area affords.

The laboratory has as its objective, through the application of breeding methods, the improvement of range sheep that will excel present sheep in adaptability, yield and quality of wool, and in lamb production. The characteristics in sheep that are of greatest value in range production are given emphasis in the breeding program.

High Production of Wool Per Sheep Important. Since emphasis was placed upon the selection for longer staple wool, for smoother sheep - which seem to favor length of staple - there has been a consistent increase in length of staple produced until in the Rambouillet flock at the laboratory between 60 and 70 percent of the total clip was graded Staple Combing. The difference in yield per fleece of the above grade and that of the shorter staple wool that grades French Combing was approximately one pound. Under existing conditions this increased yield is worth about $1.00. Inasmuch as this difference in production is essentially due to selection, which is a practical procedure for the ranchman, and as this difference in production is quite largely net gain, a fruitful means for improving the basic economy in sheep production is provided.

Selection for Smoothness in Rambouillet. Efforts to eliminate skin folds from the Rambouillet flock have been very successful. Records show that sheep bred for freedom from wrinkles in the skin over the body or neck, produce longer staple wool, and more clean, scoured wool than sheep with wrinkles. These results also provide a means for improving range sheep of the fine wool type that is within the practical reach of the ranchman. In a period of four years the Rambouillet lambs at the laboratory showed a 25 percent increase in freedom from wrinkles, indicating that the change can be effected rather quickly. The flock is now rapidly nearing the point where emphasis on skin folds will be less necessary. When this goal is accomplished it will permit the laboratory to pay increased attention to selection for other traits of economic importance such as body weight, fleece weight, and staple length.

Defective Jaws in Sheep. This defect has been analyzed and found to be an inherited character of a complex nature. When one or both parents had defective jaws 16.4 percent of the progeny were defective as compared to 1.4 percent of the progeny in a flock in which all animals were normal. Too long and too short jaws are both definite hindrances in feeding and can be eliminated from a flock by carefully selecting away from it.

Heritability of Weaning Characters. Estimates of heritability indicate that quite rapid progress can be expected in eliminating wool-blindness in those lines of the laboratory's flock where some genetic variability exists at present. A fairly rapid rate of improvement can be expected for weaning weight and staple length where selection is directed toward these ends. The results for body type score and condition score are disappointing so far as the possibility of realizing any great improvement in them is concerned. While, obviously, these two characteristics are very important as the end products in production, a study of 2,000 lambs indicates they are inherited only to a slight degree, namely 13 percent for market type (body type) and 4 percent for condition. The reason for this low heritability in sheep is due to the very high influence which environmental factors have upon market type, which itself is highly influenced by condition. In other words, when a ram lamb is superior in market type and condition or degree of finish, the chances that he will reproduce his kind are extremely small. Total production of products such as wool and weight of lamb is a much safer guide in selecting animals which will reproduce their kind.

Regional Animal Disease Laboratory: (Approved by the Secretary, February 24, 1937, located at Auburn, Alabama).

General Objectives: Livestock production in the Southeast is handicapped by the diseases and parasites that beset the animals. Livestock producers suffer not only large direct losses but are also burdened by such intangible losses as failure of young animals to grow normally and decreases in production of meat, milk, wool and eggs. The present need for animal products makes it imperative that every effort should be made to obtain maximum production economically.

The research program was planned to develop methods of controlling certain diseases and parasites for which practical measures had not been devised. The principles established in the original program will be used in determining the nature and means of control of other infectious, contagious, or parasitic diseases.

Worm Parasites of Cattle. The daily administration of 3 to 4 gram doses of phenothiazine to a group of parasitized calves resulted in the disappearance, within 15 days, of eggs of stomach worms and nodular worms. Eggs of other gastrointestinal roundworms decreased materially in numbers. The laboratory also found that the daily administration of 4 grams of phenothiazine to each of two weaned parasite-free calves grazing on a pasture infested with parasites prevented infection with stomach worms. These calves became only lightly infected with other gastrointestinal roundworms. On the other hand, untreated calves on the same pasture became moderately infected. Similar results were obtained when parasite-free calves receiving phenothiazine in daily doses were given cultures of gastrointestinal parasites. Parasite eggs voided by the treated calves failed to hatch while those from untreated controls produced viable larvae. In another test involving 11 calves, exposed to infection with larvae reared in the laboratory, it was found that daily doses of 4 to 8 grams of phenothiazine prevented infection with 2 species of stomach worms and the cattle nodular worm, and decreased materially the degree of infection with other nematodes. These results indicate that dairymen who are feeding their weaned calves while on pasture may control parasitism by mixing phenothiazine with the ground feed.

Experiments under way at the laboratory indicate that calves are much more susceptible to the bovine strain of stomach worms than they are to the ovine strain, and that lambs are more susceptible to the ovine strain. This finding is of much practical importance in the Southeast as one of the reasons frequently given for the absence of sheep on the farms of the region is the danger of transmitting stomach worms from sheep to cattle.

Bovine Coccidiosis. Calves previously exposed to Eimeria bovis, one of the two highly pathogenic coccidia of cattle, either failed to develop symptoms or developed only slight symptoms of the disease following artificial inoculation, while controls, not previously exposed, developed moderate to severe symptoms following exposure. Even though no clinical symptoms appeared following exposure the resistant calves voided cocysts in numbers comparable to those passed by the susceptible calves which developed marked symptoms.

Naturally acquired clinical coccidiosis was observed by the laboratory during the year in 3 animals one or more years old. In 2 of these, Eimeria zurnii was apparently the causative agent. This finding confirms earlier observations that the above species is associated with most of the cases of clinical coccidiosis in older cattle.

The laboratory is continuing studies on the life cycle of other coccidia that are found to be associated with symptoms of clinical coccidiosis.

Johne's Disease. The johnin test and slaughter method of control has continued to give good results. Three herds in which clinical Johne's disease has caused serious losses have now been accredited as being Johne's disease-free.

The johnin test on 536 tuberculin negative cattle at a local stockyard gave only 3 reactors. The three reactors were negative on laboratory examination for Johne's disease. A microscopic study of tissues from 102 reactors to johnin revealed 39 positive, 2 suspicious, and 61 negative for Johne's disease. It was found that 74 percent of the negative cases were in a single herd. It was impossible to determine why such a high percentage of the reactors in this group were negative on laboratory examination.

Microscopic study of tissues from 175 "no visible lesion" reactors to tuberculin was made to determine whether Johne's disease was present. The results were 31 positive, 11 suspicious, and 133 negative. Considerably more positive cases were found in specimens from the Northeast and Southeast than from the Middle West. It seems probable that some of the "no visible lesion" cases originating in the Middle West had been sensitized to tuberculin through association with tuberculous poultry. Under such conditions the tissues would not be expected to be positive on laboratory examination for Johne's disease.

There are indications that the specificity of tuberculins and johnins can be increased through chemical treatment. However, further work must be done before a definite method can be recommended and adopted.

Regional Laboratory for Improvement of Viability in Poultry: (Approved by the Secretary, December 23, 1937; located at East Lansing, Michigan).

General Objective: Paralysis of the legs and wings, defective vision, and enlarged livers are the most common manifestations of lymphomatosis, the one disease among chickens that causes an annual mortality of close to forty million adult birds. Under present price conditions these birds have an estimated value of $60,000,000. This disease is prevalent on millions of farms throughout the United States and in many other countries in the world.

The program of the laboratory was planned to determine the cause of lymphomatosis, the manner in which it was spread and methods for its control.

Cause of the Disease. The exact cause of lymphomatosis remains undetermined, although the causative agent has some of the characteristics of a virus. The disease can be reproduced experimentally by the injection of unfiltered tissue material taken from affected birds but thus far it has not been demonstrated that lymphomatosis can be produced by a filterable agent.

Transmission of the Disease. The transmission of lymphomatosis under natural conditions is being carefully studied. An analysis of five years' data involving about 4,700 chickens reveals that this disease is spread both by way of the hatching egg and by contact with infected

chickens. The exact proportion of lymphomatosis which is transmitted through eggs remains to be determined, nor has it been possible to determine the mode of transmission by contact. Because of space limitations it has not been possible to ascertain at what age transmission by contact is most likely to take place.

The results obtained in transmission studies indicated that lymphomatosis may be controlled to some extent by isolating and raising the young chickens away from the older birds, many of which are infected. The value of this practice was demonstrated by keeping a flock completely isolated to maturity (300 days), after which time these birds were housed and maintained for an additional 600 days without a single case of lymphomatosis manifesting itself, even though they were in a building with other chickens, many of which succumbed to the disease.

Transmission by Inoculation. The relatively long and variable period of one month to 3 years of age required for lymphomatosis to develop naturally among chickens, and the uncertain number of cases likely to occur have emphasized the need for developing a dependable means of inducing the disease by inoculation. The laboratory developed, over a period of years, strains of the disease which when used to inoculate chicks resulted in a large number succumbing to the disease at an early age, usually in about 10 days. Since the inocula used to reproduce the disease have contained a large number of live tumor cells the results obtained were interpreted to be caused by the transplantation of tumor cells to the recipients. Recently encouraging results have been obtained from inoculation by the use of cell-free inocula. The disease produced by inoculation and that which occurs naturally appear to have similar gross and microscopic characteristics but they differ greatly in their rate of development.

Methods of Control. Extensive research has been conducted at the laboratory to determine the value of chickens bred for resistance to the disease. The degree of success attained demonstrates the desirability of following this procedure as a control measure. For example, when the female chickens which were hatched in 1944 were 400 days of age, the 323 in the susceptible group had a mortality from lymphomatosis of 33.4 percent; whereas the 332 resistant birds which were raised with the other group had a mortality of only 12.3 percent. The difference in mortality of more than 21 percent in favor of the chickens which have been bred for resistance to lymphomatosis is certainly significant.

Poultrymen can apply the principle of breeding for resistance to lymphomatosis by mating year after year their hens which have the largest number of progeny at a given age with the assurance that the mortality in their flocks will be reduced.

No biological test has been developed that will make possible the identification of infected breeding stock thereby facilitating the removal of such birds from the breeding pens. Infected birds can be identified now only by testing the viability of the progeny from individual hens which are raised in isolation and under rigid quarantine. Such a procedure is necessarily limited to experimental work. The laboratory has not been able, as yet, to determine what proportion of eggs from affected hens are infected with lymphomatosis.

The following practices, rigidly adhered to by the laboratory, have prevented all known diseases, except lymphomatosis, and all parasites except coccidia from occurring in the flocks:

1. The maintenance of a rigid quarantine against anyone, other than employees, entering the premises, and against bringing other poultry, including breeding stock, on the premises.
2. The use of screened doors and windows, and screens over all openings, and excluding wild birds from the houses.
3. Raising and keeping the chickens in complete confinement, that is, within houses.
4. Excluding used feed bags, egg cases, chicken coops, etc. from the premises.
5. A change of outside clothing and shoes on the part of all employees before entering the poultry houses.
6. The maintenance of clean, sanitary quarters.

Many of these practices are simple enough that they can be adopted and used on many farms where the poultry enterprise is of financial importance. Preventing or reducing the number of diseases and parasites to which most poultry are exposed, would bring about more efficient production and greatly reduce mortality.

Regional Salinity Laboratory: (Approved by the Secretary, December 23, 1937, located at Riverside, California).

General Objective: There are about 20 million acres under irrigation west of the Mississippi River of which an estimated 9 million acres have had their productivity impaired or threatened by excessive accumulation of soluble salts. The prevention of salt accumulation in irrigated districts, and the removal of salts present in harmful amounts are dependent upon good drainage. The laboratory is developing and improving methods of leaching salts from soils through improved drainage, is selecting salt-tolerant crops or strains of these crops, and is determining what cultural practices will reduce salt accumulations or their effects upon plants. The aim of this program is to make available for the production of food, feed, and fiber all land suitable for cultivation and to keep that land in suitable condition for a continuing agricultural enterprise.

Alfalfa is the most important crop in the western states. In many areas the soils are salty or are irrigated with water containing appreciable amounts of salt. Under these conditions, yields of forage and seed production are reduced, and the life of the stand is shortened. Preliminary studies have been carried out to determine the salt tolerance of several varieties of alfalfa. These include California Common and Arizona Chilean which are commonly grown in the west, other varieties developed in this country, and three obtained from North Africa which show some promise of being resistant to saline conditions. In these trials, the alfalfa variety Ranger has done well under salt treatment, and the varieties Tunisia and Temacin from North Africa appear to have relatively high salt tolerance. More extensive studies are in progress with the varieties that did well in these initial trials. These will provide data on longevity of stand and the effect of successive cropping on yield under salty conditions comparable to those found in the field.

Twenty different species of grasses are being grown in both saline (0.2 percent salt) and non-saline soils in order to ascertain the relative ability of the different species to tolerate soil salinity. There is a wide variation in relative growth among the various species. The yield of Bermuda grass on the saline soil is 86 percent of that on the non-saline soil. By contrast, the production of Foxtail on the saline soil is only 15 percent of that on the control. Bermuda, Rhodes, Rescue, Alkali Sacaton, Mountain Brome and Perennial Rye grass all produced relatively good yields on saline soil. This study showed that when considering salt tolerance of plants it is necessary to distinguish between mere tolerance of the salt and the ability to make appreciable growth in its presence. For example, Western Wheatgrass, Wild Rye, Saltgrass and Tall Fescue are known to be able to survive in the presence of considerable quantities of salt, but this study indicated that the ability to grow in the presence of soil salinity does not keep pace with their ability to survive, since they produced only about 25-35 percent as great a yield as in the salt-free soil.

Studies of the laboratory indicated a wide difference in the ability of different crops to penetrate saline soil and to absorb water. In a non-saline soil, roots of beans, corn, alfalfa and cotton were found to penetrate soil readily to a depth of 33 inches, and to remove all available water. These same crops were grown on soil varying gradually in salt content from none at the surface to 0.25 percent at a depth of 33 inches. Bean roots did not enter soil containing 0.2 percent salt and were able to remove only a small amount of moisture from soil containing 0.15 percent. Corn roots barely entered soil with 0.2 percent salt and were able to remove practically no water therefrom. Alfalfa roots entered soil which contained 0.25 percent salt but were able to remove very little of the soil moisture present in such soil. Cotton roots were not only able to enter soil containing 0.25 percent salt but were able to remove most of the available water present in such a soil.

The slow rate of water infiltration on slightly saline lands used for spreading spring flood waters to replenish underground supplies is a serious problem in areas where pumping is relied upon for irrigation purposes. Rates of infiltration of water into the soil may be reduced to such a low value that water spreading would be questionable from an economic standpoint. The continued use of such lands is dependent upon the determination of the causes of decreasing permeability in these areas and the development of methods to eliminate them. Laboratory studies have been conducted using undisturbed soil cores taken from the field. It was found that the resistance to infiltration usually occurred in the surface few inches and that the reduction in permeability appeared to be related to biological growth under submerged conditions. Drying the soil and the use of disinfectants tend to maintain high rates of water infiltration. These studies have been in cooperation with the Bureau of Reclamation, Soil Conservation Service, the State of California, and two Water Storage Districts.

U. S. Plant, Soil, and Nutrition Laboratory: (Approved by the Secretary, January 1, 1939; located at Ithaca, New York).

General Objective: Physiological disorders of man and animals in certain sections of the country have claimed increasing interest of research and nutrition specialists in recent years. The cause of many of these disorders has been identified as a deficiency of one or more essential nutrients in the food or feed eaten. Interest is being centered on the role of the soil in supplying to man and animals, through the medium of the plants grown on them, the nutritional factors required for normal health and well-being. From a national nutritional standpoint it is essential to know what areas are supplying adequate foods and feeds and what areas are supplying inadequate foods and feeds to the men and animals residing there. In the latter case it is necessary to know the extent and nature of the deficiency so that it may be corrected by direct additions to the diet or supplied to the plants in the form of fertilizers or by other agricultural practices.

Factors Influencing the Vitamin Content of Plants. In order to study variations in the ascorbic acid (vitamin C) content of tomatoes, samples of ripe fruit of three or more varieties from seventeen widely separated locations in the United States were shipped to the laboratory for analysis. It was found that variations in the average values of ascorbic acid, considering all varieties and all locations, were from 8.4 to 30.6 mg. per 100 grams of fresh fruit. One individual variety varied from 10.7 to 29.0 mg. These wide variations in ascorbic acid values, associated with the location where the plants are grown, did not seem to result from differences in soil, but rather from climatic variables. In order to determine the effect of environmental factors, the laboratory studied the influence of ripeness at time of picking and of storage for 10 days at temperatures varying from 65 to 90° F. on ascorbic acid content of the fruit. Neither factor had any significant influence on ascorbic acid content.

One tomato variety grown under controlled conditions with variations of exposure to temperature and humidity showed that neither of these variables produced a marked effect on the ascorbic acid content. Plants grown on an 8-hour photoperiod were lower in ascorbic acid than those grown on a 16-hour period, but the difference was not great. In contrast, the amount of illumination of plants prior to harvest had a marked influence on ascorbic acid values. Transferring plants from shade to sunshine at the time the fruits were "mature green" resulted in a rapid increase in the ascorbic acid values of the fruits, so that at the time the fruits ripened the ascorbic acid content was equal to that of the plants grown continuously in sunshine. Similarly, transferring plants from sunshine to shade brought about a decrease in ascorbic acid.

The establishment of a minimum level of 20 mg. of ascorbic acid per 100 ml. of tomato juice for those cans bearing the "accepted" seal of the American Medical Association's Council on Foods has served to emphasize the practical importance of the laboratory's studies on tomatoes. Results have indicated that fresh tomatoes of many varieties frequently contain much less than 20 mg. of ascorbic acid per 100 g. of fresh weight. Under such conditions it is impossible to obtain tomato juice from such fruit which would meet the above standard.

Distribution of Vitamins in Wheat. The laboratory has developed a simple method, involving fluorescence microscopy and photomicrography, for determining the location of thiamine and riboflavin in a single wheat grain. The method should prove useful to the wheat breeder in conjunction with the selection of varieties and strains of wheat which will give a high-vitamin flour. At present each wheat selection must be produced in sufficient quantity to provide grain for a trial at an experimental mill before knowledge of the vitamin content of the flour is obtained. The new method should speed up selection by eliminating low vitamin wheats very early in the breeding program.

Effect of Phosphorus Fertilization on Feeding Value of Crops. No significant difference was noted in the growth of lambs fed Canada field pea hay fertilized with and without superphosphate. The phosphorus study is being extended through a cooperative project with the North Carolina Agricultural Experiment Station. Soybeans and corn are now being produced on a soil very deficient in phosphorus with a fertilizer differential of superphosphate. Feeding, digestion and nitrogen balance trials will be conducted with lambs this fall to ascertain whether superphosphate fertilization increased the feeding value of these crops.

Manganese Studies. It was previously reported that in the absence of manganese the leg bones of rabbits were crooked, stunted and brittle. During the past year the laboratory found a clue suggesting the role of manganese in the animal body. It was observed that an important enzyme (alkaline phosphatase) in the bones was decreased in manganese-deficient rabbits. It is probable that the impaired development of bone in manganese deficiency is explained by the decreased phosphatase activity. The laboratory has established that the manganese requirement of the rabbit is 1 milligram or less per day. Preliminary tests of forages from certain "sick" areas in North Carolina using the rabbit as a test animal have given some evidence that the forages are deficient in manganese. This finding may be at least a partial explanation of why cattle and sheep grazing in these areas progressively fail in health.

Survey of Soil and Animal Disease Interrelationships. The distribution of the nutritional troubles in both plants and animals in the United States has been plotted on maps at the laboratory. In the plant series there are outlined the generalized areas and the principal crops associated with deficiencies of boron, manganese, zinc, copper, magnesium and iron. The map of animal troubles shows the locations where deficiencies of calcium, phosphorus, cobalt and copper have been reported and where selenium toxicity is found. A generalized iodine-deficient area is also shown. There has been an increase in the number of reports of deficiencies of cobalt in cattle in the last two or three years. It appears possible if these reports are further substantiated that eventually cobalt-deficient areas may be defined over much of the Atlantic Coastal Plain and over the Northeast from Wisconsin through New England.

Special Research Projects:

Part of the Special Research Fund is available to the Secretary of Agriculture for special research projects. This part of the fund is intended primarily to enable the Secretary to undertake studies which are basic to agriculture in its broadest aspects and which may be conducted by such agencies of the Department as he may designate or establish. The act requires that the research under this fund "shall be in addition to research provided for under existing law (but both activities shall be coordinated so far as practicable)". The solution of many problems which arise requires research of fundamental character in order that further progress may be made. The appropriation enables the Secretary to undertake such work within the limits of available funds.

In administering, budgeting, and using the Special Research Fund, no money is allotted to the bureaus which conduct the research until carefully written project plans and cooperative arrangements are outlined in detail and approved by the Secretary. Allotments are adjusted on the basis of changes in relative needs of the projects which are under way.

Examples of Progress and Current Programs: During the ten years that the Special Research Fund has been available, 99 separate research projects have been undertaken and 72, constituting 73 percent, have been terminated. Of those terminated, 37 were relatively short-time studies designed to provide information for immediate needs. Of the other 35 projects, 10 were terminated in 3 years, 7 in 4 years, 3 in 5 years, 6 in 6 years, 2 in 7 years, 4 in 8 years, and 3 in 9 years. One project was terminated in 1945. A total of 27 projects, involving 8 bureaus, are now under way.

The majority of these 27 projects are concerned with fields of work basic to agriculture in its broadest aspects. As the work progresses and as the needs vary, changes in emphasis are made from year to year. With the completion of work on one phase of a problem, the attack may be directed to another phase requiring solution.

The following are examples of progress made in special research projects during the fiscal year 1945:

Weed Eradication through the Use of Plant Hormones. The compound, 2,4-dichlorophenoxyacetic acid, was found to be highly effective in killing certain weeds. A method was developed for the selective control of some turf weeds and some kinds of weeds that are often

associated with such crops as corn and grains. The compound was found to be very effective in the eradication of plantain, dandelion, western bindweed (grown under greenhouse conditions in preliminary experiments), morning glory, hydrocotyle, heal-all, woodsorrel, chickweed, pigweed, knotweed, Japanese honeysuckle, and some other less important weed pests.

Only small amounts of the chemical need be used in the eradication of many kinds of succulent weeds that are sensitive to the compound. 0.0125 to 0.1 percent aqueous solutions of the acid, applied as a spray at the rate of 1.75 lbs. of the active ingredient per acre proved to be very effective. It was shown that 2,4-dichlorophenoxyacetic acid was effective in killing such pests as plantain when the compound was applied to dormant plants during the cold weather of late fall. The effects of treatment, however, did not become apparent until the plants were subjected to an environment favorable for vegetative growth. The cost of materials used in the eradication of plantain, for example, ranged from $2.30 to $4.70 per acre, exclusive of labor and based on prices current at the time of experiments reported here. Fleshy-rooted plants such as dandelion died and decomposed within a period of 2 to 4 weeks after treatment. Killing of both succulent and fleshy-rooted weeds was obtained most quickly under conditions that favored plant growth.

Eradication of weeds was accomplished by applying 2,4-dichlorophenoxyacetic acid in aqueous solution or suspension, as an aerosol, and more recently when applied in dusts. The sodium and ammonium salts of 2,4-dichlorophenoxyacetic acid were also found to be effective as weed killers.

Effect of Hormones on the Growth and Development of Fruits and Vegetables. Treatment of fruits and vegetables with sprays composed of synthetic hormones has given such promising leads that it has opened up a whole new field of development. When the open and unopened flowers of a blackberry seedling were sprayed with a solution containing 40% of parachlorophenoxy-acetic acid and 60% of beta-naphthoxyacetic acid the plant developed fruit which weighed on an average 99% more than did those of comparable untreated plants.

A number of compounds were tested on greenhouse tomato plants to ascertain their efficacy for improving production. The fruit set of greenhouse plants was increased by treating open flowers or well developed buds with growth-regulating substances by means of the aerosol method. The rate of early growth of fruit from treated flowers was from 10 to 50 percent greaterr than that of fruit from untreated flowers. The weight of ripe treated fruit of certain varieties (Bonny-Best, Marglobe, and Pan-American) was from 10 to 27 percent greater than that of the untreated ones. Treated fruits of the same varieties ripened from 8 to 10 days sooner than untreated ones.

Continued studies on preharvest fruit spray of apples revealed that the addition of Carbowax to naphthaleneacetic acid extended the effective period for preventing fruit drop by approximately 50%, as compared with the effective period which resulted from the use of naphthaleneacetic acid alone. The use of 2,4-dichloro-phenoxyacetic acid to prevent preharvest drop of apples resulted in an extended period of protection against drop 3 weeks longer than did the conventional treatment with naphthaleneacetic acid.

The rate of ripening of detached banana, apple and pear fruits was greatly accelerated by dipping the fruit into or spraying the fruit with aqueous solutions containing 2,4-dichlorophenoxyacetic acid. Pears ripened more uniformly when the dipping treatment was used. Parsnips were made to "cure" more rapidly following harvest as the result of dipping them in an aqueous solution of 2,4-dichlorophenoxyacetic acid.

Storage of soybeans on the Farm. Preliminary observations indicate that soybeans with a moisture content of 10 to 12 percent are best for safe long-time storage. Very low moisture soybeans (below nine percent) split easily resulting in handling losses. Soybean moisture contents above 13 percent generally were associated with a higher respiration rate, greater moisture redistribution, higher grain temperatures, increased insect infestation, higher fat acidity, and decreased germination.

Moisture movement and accumulation in stored soybeans appears to be an important factor in safe storage. In soybeans with moistures above 12 percent, accumulations of moisture too high for safe storage may occur in the upper part of the bin. Such accumulations are more pronounced in steel bins than in wooden bins, and more in the larger wood bins than in the smaller ones.

Wind ventilated bins were not effective in drying out high moisture soybeans during the winter and spring of 1944. Soybeans from such bins graded sample when removed after 6 months of storage. The principal reason for the small amount of drying in these bins apparently was the lack of sufficient air movement through the soybeans. The only advantage of these bins was the cooling effect of the ventilators during the winter months, but this effect was offset by the fast warming up of the soybeans when warm weather arrived.

Preliminary studies of pressures exerted by soybeans on bin walls indicated somewhat lower pressures than those exerted by corn or wheat. In a wood bin 12 feet wide outward pressure on the wall increased approximately 14 pounds per square foot and downward pressures on the wall, due to friction, 8.5 pounds per square foot for each foot of depth. The maximum outward pressure was registered about 15 days after the bins were filled.

Analysis of the Position of Oil Crops in American Farming. A careful analysis is being made of the economic position of the oil crops as an aid in appraising the whole pattern of our future agricultural production.

The demand for fats and oils after 1950 will probably be increased in the United States to a greater extent than in foreign countries because of basic economic conditions and recovery from the war more rapidly here than elsewhere. Assuming moderately good employment and business conditions, some very tentative estimates suggest that domestic consumption will amount to around 11 billion pounds as compared with about 9 billion pounds in 1935-39 and about 10 billion in 1943.

The probable increase in food uses is less than that in non-food uses. Aggregate food uses of fats and oils (about two-thirds of the total before the war) may increase only slightly more than the expected increase in population. Non-food uses, on the other hand, probably will increase significantly on a per capita basis. Paints and varnishes and miscellaneous industrial uses are expected to account for the largest percentage increases. A substantial upward trend in use of soap is also expected. The increased paint and varnish and industrial uses are related to an expected expansion in the building and construction industries in the postwar period.

The postwar outlet for protein feed will be an important factor affecting the prices of oil crops, especially in the case of soybeans. Preliminary estimates were made of the theoretical protein needed to balance the livestock rations actually fed in the feeding year 1941-42. These calculations show that about 10 percent more protein than was contained in all feed except pasture, would have been needed to make up the theoretical deficit. If this deficit were to be made up entirely from high protein feeds, an increase of about 75 percent in such feeds would be required. Progress in hay and pasture improvement will make up part of the protein deficit. It is entirely possible that farmers may not actually buy as much protein as feeding recommendations suggest they should. There is good reason to believe, however, that the wartime experience in feeding high protein feed will permanently increase the effective demand for such feeds.

Biologically Active Chemical Compounds in Growing Plants. Tomato varieties have been developed that are almost completely resistant to Fusarium wilt, a disease which constitutes a major economic problem in many regions of the United States. The mechanism of tomato wilting is obscure but there is some evidence to indicate that the plant juice contains a toxin which is elaborated by the causal fungus of Fusarium wilt. It was assumed that resistant plants are able to produce a substance or substances which either neutralize the toxin directly or retard its production by inhibiting the growth of the fungus.

Preliminary tests in this experiment indicated that aqueous extracts of a highly resistant tomato (Pan American) exhibited definite fungistatic activity toward the wilt organism. By fractionation and concentration procedures it has been possible to obtain from the expressed juice of Pan American tomato plants a preparation which, while still impure, possesses marked fungistatic activity to the Fusarium organism. This antibiotic agent occurs throughout the entire plant.

Efforts are continuing to further purify and eventually to isolate and identify this agent and to determine its specificity with regard to the tomato wilt organism.

If it can be demonstrated that this antibiotic agent is involved in protecting tomato plants against invasion by the wilt fungus then it should be possible for plant breeders to use an assay method as a means of testing large numbers of tomato plant progeny rapidly and accurately for the wilt resistant character.

Crossbreeding Dairy Cattle. Further information has been obtained as a guide for predetermining the quality of offspring when the crossbreeding of dairy cattle is practiced.

To date, 23 cows of 2-breed crosses have completed records. The average production of the 23 animals, calculated to a mature basis, is 17,661 pounds of milk, containing 811 pounds (4.59 percent) of butterfat. The average mature equivalent yield of their dams was 13,564 pounds of milk, containing 610 pounds (4.49 percent) of butterfat. The difference is an increase over the dams of 30,2 percent for milk yield and 32.9 percent for butterfat yield.

Four 3-breed females are now in milk and an additional such female has completed her record. The record for the complete lactation is 13,992 pounds of milk containing 609 pounds (4.35 percent) of butterfat, compared to the record of the 2-breed dam of 13,065 pounds of milk, containing 615 pounds (4.71 percent) of butterfat. The 3-breed crosses are equalling or exceeding the records of their 2-breed dams at comparable stages of lactation.

Mineral Nutrition of Flue-Cured Tobacco. In this study an attempt has been made to determine the specific role of the several essential nutritive elements in influencing the character of growth and development of tobacco and the various factors of quality of the cured leaf.

The boron content of flue-cured tobacco showing boron deficiency symptoms was 6.5 parts per million and that of normal plants from the same field was 9 parts per million. It is believed that while the minimum requirements may vary under different conditions, about 10 parts per million are probably as little as are usually present in normal flue-cured tobacco. The copper content of normal plants was in some cases as little as 6 and 7 parts per million, and the minimum appeared to be 5 parts per million. Normal plants from some treatments contained slightly less than 10 parts per million of zinc which appeared to be close to the minimum requirement. The content of manganese was quite variable. The lowest values found in normal field tobacco was 72-85 parts per million. In these experiments the absorption of a given trace element was independent of the supply of other trace elements.

During the 1944 growing season the potash component of the basal fertilizer treatment was increased from 48 to 80 pounds per acre.

In addition to preventing appearance of potash deficiency symptoms, the additional potash apparently modified materially the response of the crop to application of some of the trace elements. In the case of boron, application of one-half pound per acre gave an apparent increase in yield of 138 pounds per acre, whereas no material gain in yield had been obtained in previous years. In addition, there was practically no reduction in yield following the addition of 2.5 pounds of boron per acre, while previously there had been an average reduction in yield of 189 pounds per acre following such boron treatment. With the increased rate of potash fertilization copper apparently was beneficial at all rates of application and the increases in yield obtained were 141, 162, and 103 pounds per acre with copper used at the rates of 1, 2 and 5 pounds per acre. In previous years the lower rates of copper application were without practical effect and the heaviest rate was somewhat toxic, reducing the yield about 90 pounds. The effects of zinc and manganese seem not to have been materially influenced by the rate of potash fertilization.

The Effect of Light on Plant Growth and Development. A study of the effect of day-lengths of 12, 13, 14, and 15 hour periods was made on the soybean varieties Ogden, Volstate, Macoupin and Arksoy. On these respective day-lengths flowering of the 4 varieties took place on the average 34, 35, 44 and 63 days after planting. The mean number of pods per plant was greatest on 14-hour and least on 12-hour day-lengths. Mean weight of seed per plant was greatest for 14-hour lots and least for 15-hour ones. The low yields of seeds on 15-hour plants was the result of late maturity induced by long day-lengths. The variability in date of opening of first flowers was greatest in the lots on long day-lengths and least in those on short ones. These results may have practical significance in selecting for early or late types from segregating populations in a breeding program.

A group of 23 commercial varieties of onions was grown on day-lengths in midsummer of 12, 13, 14 and 15 hours and on natural day-length. All of the varieties formed bulbs on natural and on 14 and 15-hour day-lengths. The bulbs of all varieties produced on 15-hour day-lengths matured. Only 2 varieties on the 14 hour and 4 on the natural day-length failed to mature. On 13-hour day-lengths 10 varieties formed bulbs and 4 matured, while on 12-hour day-lengths five varieties formed bulbs and only 2 matured. The number of days from planting until bulbing became visible was about the same for the 14-hour lots as for those on natural day-lengths, but the lots on 15-hour day began bulbing about a week earlier than those on a 14-hour day. These results indicate the need for selecting varieties adapted to the length of day in the region where the onions are to be grown.

Administration of Payments to States under Title I, Bankhead-Jones Act

During the fiscal year 1945, the administration of the provisions of Title I of the Bankhead-Jones Act of June 29, 1935, which authorized payments for agricultural experiment stations, involved:

(a) Critical examination and approval, in advance of the expenditure of funds, of research projects, there being 1,132 active Bankhead-Jones projects during the fiscal year, of which 247 were either new or revised.

(b) Review in the field of the work and expenditures at the State agricultural experiment stations under funds totaling $2,463,708 provided under Title I of the Bankhead-Jones Act and apportioned on the basis of rural population.

(c) Review in the field of research and research facilities of the stations supported by $2,463,708 from non-Federal sources advanced as offset credit to meet the requirements of Section 5 of the Bankhead-Jones Act.

(d) Special examination of any expenditures from the allotments under the Bankhead-Jones Act made for the construction, equipment, and maintenance of buildings and purchase and rental of land to ascertain that such expenditures were necessary for the research supported by the funds provided by the Bankhead-Jones Act.

(e) Assisting in coordinating the research under this Federal-grant fund between the State stations and with the research of the Department, and maintaining advisory relations with the State stations on technical and administrative matters pertaining to their research programs and station organization.

(f) Reporting to the Secretary and the Congress on the work and expenditures under this Federal-grant fund.

Specific examples of the type of work done under this project are given below in the statement for the Office of Experiment Stations under the appropriation "Payments to States, Hawaii, Alaska, and Puerto Rico for Agricultural Experiment Stations" and under the subappropriation for administration of grants to States.

PASSENGER-CARRYING VEHICLES

The estimate for the purchase of passenger-carrying vehicles for the Special Research Fund, Department of Agriculture contemplates an increase of $650 ($1,600 in 1946; $2,250 estimated for 1947) for this purpose. The total estimate of $4,450 will permit (1) the operation and maintenance of 11 and (2) the replacement of 3 vehicles, or approximately 27 percent of the total number in use, at a net cost of $2,250 when exchange allowances are taken into account. No funds are requested for the purchase of additional vehicles.

Cars operated under the Special Research Fund are used only for essential research activities in areas where other means of transportation are inadequate or nonexistent. In some instances where common carrier travel is not suited to the work, employees are reimbursed at a rate not exceeding 5 cents per mile for the use of personally-owned automobiles. Travel of this sort, however, is a very small portion of the total.

During the war there were very few replacements of automobiles operated under the Special Research Fund. The 3 cars proposed for replacement were purchased in 1938, 1939, and in 1940 and at the time of trade-in will have approximate mileages of 90,000, 55,000, and 50,000, respectively.

OFFICE OF EXPERIMENT STATIONS

(a) Payments to States, Hawaii, Alaska, and Puerto Rico for Agricultural Experiment Stations

Appropriation Act, 1946	$7,206,208
Budget estimate, 1947	7,552,500
Increase	+346,292

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Hatch Act (March 2, 1887)	$720,000	$720,000	$720,000	- -
2. Adams Act (March 16, 1906)	720,000	720,000	720,000	- -
3. Purnell Act (February 24, 1925)	2,880,000	2,880,000	2,880,000	- -
4. Bankhead-Jones Act: (June 29, 1935)	2,463,708	2,663,708	3,000,000	+$336,292 (1)
5. Hawaii Station Act: (May 16, 1928)	90,000	90,000	90,000	- -
6. Alaska Station Act: (February 23, 1929)	15,000	15,000	15,000	- -
7. Alaska Station Act: (June 20, 1936)	22,500	27,500	37,500	+10,000 (2)
8. Puerto Rico Station Act (March 4, 1931)	90,000	90,000	90,000	- -
Total estimate or appropriation	7,001,208	7,206,208	7,552,500	+346,292

INCREASES OR DECREASES

The total increase of $346,292 in this item for 1947 consists of the following:

(1) An increase of $336,292 to carry out the provisions of Title I of the Bankhead-Jones Act of June 29, 1935, which authorizes an appropriation of $3,000,000, the amount recommended, for the State, Hawaii, Alaska, and Puerto Rico Agricultural Experiment Stations for the fiscal year 1947:

Objective: To more adequately promote the production, distribution, and utilization of essential food and other agricultural products and to secure information needed for the maintenance of a permanent and efficient agricultural industry by providing funds for research by the State, Territorial, and Puerto Rico agricultural experiment stations.

The Problem and its Significance: The demands of agriculture call for additional research to provide sufficient technical information needed for the production and effective distribution of agricultural products and for wise use of agricultural resources under the changing conditions now faced and in prospect.

The State agricultural experiment stations have responsibility to carry on research and experimentation directed to the solution of problems of the individual States, and for participation with the U. S. Department of Agriculture in developing information contributing to the welfare of the Nation as a whole. The problems to be met through station research vary with locality and season, and with shifts in requirements for agricultural products. Greatly expanded demands for food, fibers, oil, and other farm products have brought new problems to the Stations for solution. Problems of transporting products and supplies, of best ways of processing and storing, of substitution for critical materials in short supply, and of helping to alleviate farm labor shortages require increasing attention. National consciousness of the importance of adequate nutrition calls for new facts on nutritive requirements and nutritive values of foods.

Already, farmers are beginning to raise questions for guidance in production for present and future requirements with renewed emphasis on advancement of the science of farming, on quality and economy in production, on conservation of land and other resources, and on renewal and restoration of the farm physical plant.

The agricultural experiment stations will need additional funds in order to meet the many problems arising from the current situation. This will require intensification of work in progress and the undertaking of new investigations. The following may be cited as subjects requiring additional research by the experiment stations:

Postwar agriculture: The period ahead will involve important shifts from crops needed to supply world war demands to those needed in peacetime. Skillful planning by farmers and the wide use of technical information will be necessary.

Much technical guidance will be needed in dealing with the complicated factors related to the marketing and distribution of products. Demands in this field are typified by the request of a national farm organization to the chairman of the experiment station directors group in each major agricultural region for intensified and coordinated research in the marketing of livestock.

The need for an accelerated and more comprehensive research program as a basis for changes in agriculture in the cotton producing areas has been emphasized. Plans are being formulated for coordinated investigations of various problems involved regionally and by States. The stations will need additional funds to carry out the part of the research program which they are best qualified to undertake.

More than ever before farmers and the general public are interested and concerned that agriculture, in making adjustments to changing conditions, should use agricultural resources best to conserve and improve them. The problem is no longer one of general information. The many type-of-farming areas, the individual localities, and the farms are directly concerned. Problems of suitable crop varieties, crop rotations, pastures, fertilization, drainage, and combinations of crops and livestock are involved. Because of their background of experience and familiarity with local conditions, the experiment stations are best prepared to carry on much of the research to furnish the information needed.

Changes in technology: The war brought new developments in technology. Many of these will be applied to the agricultural field. Developments are expected in the use of new chemical products such as the sulfa drugs and penicillin and other antibiotics in the control of animal diseases. The possibility of reducing the serious losses due to insect pests and diseases of plants by use of new materials such as DDT and other organic chemicals has stimulated widespread interest in the development of new information. Other new technologies are involved in the heavy and deep fertilization of crops, farm mechanization, and transportation. The necessary fact finding for the extension of these new tools to the full benefit of the public depends upon a continuing, energetic, and well-supported research program which will furnish specific information applicable to local type-of-farming areas and to combinations of crops and market outlets.

Availability of Funds: As stated in the justifications supporting the estimates for 1946, the States have increased their support of the agricultural experiment stations from approximately $2.10 to $1.00 of Federal funds in 1940 to $3.01 to $1.00 in 1945. Although complete figures are not available at this time, current information indicates no reduction in State support for 1946 and 1947. In considerable degree the State funds are appropriated for research on specified State and local problems. Usually they are not readily available for work on regional and national problems. The Federal-grant funds permit the State stations to cooperate with the Department in securing information needed on a national basis and are also available to meet the needs of the individual States. Some of the recent increases in State funds have been set aside for restoration of the physical plant of the stations when labor and materials are available. The continuance of effective research by the stations will require the replacement of worn-out or obsolete equipment with new equipment. It is expected that the increase in Federal-grant funds will be used to provide some of the equipment and facilities needed for approved research projects and for a portion of the increased expenses involved in the present higher cost level.

Authorization: Provisions of the Bankhead-Jones Act of June 29, 1935, Title I, Section 2, authorize and direct the Secretary of Agriculture to encourage research by the State, Hawaii, Alaska, and Puerto Rico agricultural experiment stations along lines prescribed by the Act. For this purpose, there is authorized to be appropriated the following amounts to be apportioned primarily on the basis of rural population: Fiscal year 1936, $600,000; fiscal year 1937, $1,200,000; fiscal year 1938, $1,800,000; fiscal year 1939, $2,400,000; fiscal year 1940 and thereafter, $3,000,000. Beginning with the fiscal year 1939, the full amounts have not been appropriated, as shown in the following tabulation:

Fiscal Year	Authorized by Title I of the Bankhead-Jones Act	Budget Estimate	Appropriation Act
1939	$2,400,000	$1,800,000	$2,100,000
1940	3,000,000	2,400,000	2,400,000
1941	3,000,000	2,400,000	2,400,000
1942	3,000,000	2,400,000	2,463,708
1943	3,000,000	2,000,000	2,463,708
1944	3,000,000	2,463,708	2,463,708
1945	3,000,000	2,463,708	2,463,708
1946	3,000,000	3,000,000	2,663,708
1947	3,000,000	3,000,000	

Total allotments from Title I of the Bankhead-Jones Act to the various State and Territorial agricultural experiment stations as appropriated during the fiscal years 1942 through 1946 and according to the estimate for 1947 are indicated in the following Table I:

(Continued on next page)

TABLE I

ALLOTMENTS TO STATIONS UNDER THE BANKHEAD-JONES ACT OF JUNE 29, 1935
TITLE I, AS APPROPRIATED 1942, 1943, 1944, 1945, 1946, AND BUDGET ESTIMATE 1947

	Appropriated 1942, 1943, 1944, 1945	Appropriated, 1946	Estimate, 1947	Increase, 1947 over 1946
Alabama	$82,695.12	$89,423.98	$100,738.23	$11,314.25
Alaska	2,252.44	2,440.15	2,755.77	315.62
Arizona	13,285.16	14,392.26	16,253.80	1,861.54
Arkansas	63,983.20	69,148.00	77,832.33	8,684.33
California	81,893.64	88,718.14	100,193.21	11,475.07
Colorado	22,430.96	24,243.47	27,291.14	3,047.67
Connecticut	22,507.32	24,382.95	27,536.72	3,153.77
Delaware	5,189.96	5,622.44	6,349.66	727.22
Florida	34,782.16	37,680.70	42,554.44	4,873.74
Georgia	87,522.92	94,499.88	106,231.29	11,731.41
Hawaii	9,186.40	9,727.90	10,638.40	910.50
Idaho	14,219.84	15,404.82	17,397.33	1,992.51
Illinois	86,736.52	93,841.72	105,788.75	11,947.03
Indiana	62,900.44	68,142.18	76,955.90	8,813.72
Iowa	64,854.64	69,803.53	78,124.80	8,321.27
Kansas	50,050.96	53,614.75	59,607.11	5,992.36
Kentucky	81,533.32	88,327.80	99,752.39	11,424.59
Louisiana	56,502.80	61,211.39	69,128.66	7,917.27
Maine	20,692.16	22,403.10	25,293.40	2,885.30
Maryland	30,259.72	32,781.37	37,021.41	4,240.04
Massachusetts	18,674.92	20,231.15	22,847.91	2,616.76
Michigan	73,566.60	79,697.18	90,005.45	10,308.27
Minnesota	57,269.04	62,041.49	70,066.12	8,024.63
Mississippi	72,651.40	78,610.71	88,630.98	10,020.27
Missouri	76,967.80	83,175.72	93,614.07	10,438.35
Montana	15,503.16	16,687.31	18,678.42	1,991.11
Nebraska	38,776.60	41,505.16	46,093.12	4,587.96
Nevada	2,734.64	2,962.52	3,345.70	383.18
New Hampshire	8,507.40	9,216.35	10,408.42	1,192.07
New Jersey	31,260.32	33,865.35	38,245.59	4,380.24
New Mexico	14,516.00	15,725.69	17,759.70	2,034.01
New York	94,478.24	102,351.45	115,589.90	13,238.45
North Carolina	106,085.56	114,926.05	129,790.93	14,864.88
North Dakota	24,675.76	26,411.59	29,330.32	2,918.73
Ohio	93,717.64	101,527.46	114,659.33	13,131.87
Oklahoma	68,450.84	73,409.01	81,745.94	8,336.93
Oregon	22,790.32	24,689.53	27,882.95	3,193.42
Pennsylvania	135,322.64	146,599.59	165,561.23	18,961.64
Puerto Rico	53,213.24	57,647.71	65,104.04	7,456.33
Rhode Island	2,449.04	2,653.11	2,996.27	343.16
South Carolina	59,464.96	64,344.59	72,549.44	8,204.85
South Dakota	24,432.44	26,082.74	28,857.61	2,774.87
Tennessee	77,136.04	83,564.08	94,372.51	10,808.43
Texas	149,364.76	161,283.81	181,338.55	20,049.74
Utah	10,503.68	11,336.91	12,737.97	1,401.06
Vermont	10,471.60	11,274.80	12,625.36	1,350.56
Virginia	71,144.56	77,043.23	86,961.54	9,918.31
Washington	33,254.64	36,025.87	40,685.56	4,659.69
West Virginia	55,859.16	60,514.12	68,341.20	7,827.08
Wisconsin	60,224.88	65,188.75	73,535.25	8,346.50
Wyoming	6,759.52	7,294.44	8,193.88	899.44
Total	$2,463,707.08	$2,663,708.00	$3,000,000.00	$336,292.00

(2) An increase of $10,000 to carry out the provisions of the Act of June 20, 1936, which authorizes an appropriation of $37,500 for the fiscal year 1947 for the Alaska Agricultural Experiment Station:

Objective: To provide for the necessary expenses of conducting investigations, experiments, and scientific researches which have for their purpose the establishment and maintenance of a permanent and efficient agricultural industry as provided by the Adams Act of 1906 and the Purnell Act of 1925 extended to include Alaska by the Alaska Act of June 20, 1936.

The Problem and Need: Military and civilian population increases in Alaska during the war years and the expected future development have intensified the demand for information that will lead to increased and more efficient agricultural production. Results from agricultural investigations by the Alaska station have been extremely helpful in going part of the way in providing help on such questions as crop and livestock production practices likely to be most successful. Unfortunately, the amount of information available from research is entirely inadequate for answering the many problems confronting the development of an efficient and permanent agricultural industry in Alaska. The extent of the demand for factual information on agricultural problems is illustrated by the fact that inquiries from service men and civilians received by the station have been as many as 25 in a single day. To answer these questions as well as meet the everyday demands of farmers currently operating in the various areas of the Territory, there is need for specific facts on many problems of soils, crops, livestock, insects, and diseases. There are hazards in agriculture in Alaska, and the only way that these risks can be reduced to a minimum is through intensified agricultural research to determine production systems for both crops and livestock.

There is a need for information on various crops that can be produced under the existing conditions and methods of production involving such cultural practices as methods and dates of planting and fertilization. A program of such research is under way at both Fairbanks and Matanuska, but it should be expanded to include more extensive work with pasture and forage crops, to determine the best species and management systems that give maximum yields. As an example of the results of this type of experimentation, it was shown by the Matanuska station in 1944 that the application of 600 pounds per acre of a 4-6-10 fertilizer gave a yield of 429 bushels per acre of potatoes in comparison with 245 bushels per acre for areas not fertilized. The potatoes receiving fertilizer produced the greatest number of tubers per hill, the largest total weight, and the highest starch, ash, and dry-matter contents which are important factors in determining food value. The response of potatoes and other crops to fertilizer under experimental conditions, as well as observations on general growth and vigor of plants, both at Matanuska and Fairbanks, strongly indicate that inherent soil fertility is not as high as many of the farmers believe. In order to determine the

economic limits of fertilizer and lime use, as well as the possible value of certain minor elements on Alaskan soils, it is proposed that a portion of the authorized increase be used for additional field and new greenhouse experiments. Greenhouse facilities are available at Matanuska, but it is necessary that certain minor repairs be made to an existing unit. The University of Alaska proposes building a greenhouse at Fairbanks, a part of which it is understood will be available for station work. Technical personnel is available at both stations for conducting this work. Major items of expenditures will be for supplies and equipment. Approximately $1,000 would be needed for this item.

The station is attempting to provide information requested by farmers as to the value of rations from locally grown grain and forages. Recommended rations for dairy cattle, calves, pigs, and breeding ewes have been developed from feeding trials extending over several years. Unfortunately, neither personnel nor laboratory facilities have been available for making chemical determinations of the content of important nutrients in the feedstuffs under investigation or the excreta, blood, and tissues of animals. An adequate chemical laboratory and a competent chemist are indispensable factors in a productive animal nutrition research program. Ability to analyze feedstuffs for such ingredients as protein, calcium, phosphorus, and carotene would have permitted the research workers to predict, with reasonable accuracy, the feeding value of the various feeds involved and thus have avoided a great deal of empirical trial-and-error type of feeding experimentation. It is reasonable to believe that adequate facilities for the chemical analysis of feeds and animal products would reduce by half the number of feeding experiments necessary to establish the feeding value of various combinations of feeds for the different classes of livestock, as compared with the present procedure of compounding experimental rations with no information regarding the chemical composition of the various components in the rations. It is proposed that the major portion of the authorized funds be used to obtain the services of a chemist and provide the necessary equipment for chemical work.

Another problem confronting the livestock farmers is the curing and harvesting of forage and grain crops under adverse weather conditions. If farming in general is to prosper and further settlement is to be encouraged, it is of great importance that farmers be enabled to produce feed for livestock on an economic basis. In an attempt to help on this problem, the Matanuska station proposes to install equipment to determine the practicability of artificial mow-curing of mixed hay crops. The study will include the value of both heat and air in drying. If chemical services can be obtained, the value of different methods of curing can be quickly determined. Preliminary work is now in progress on this problem with oat pea hay. In order to provide for the development of methods of curing of other forages, approximately $500 additional will be needed.

The above statements regarding the lack of information on the value of various animal feeds applies equally well to human foods. Many of the farmers point out that Alaska-produced foods are at a disadvantage because of an existing public belief that they are inferior in nutritive value to foods produced elsewhere. For example, many individuals indicate that their teeth have gone bad in Alaska because of the inferior quality of Alaska-grown foods. From the standpoint of health and human welfare and the future of agriculture in the Territory, studies of locally grown foods should be undertaken as soon as possible to determine if there is any basis for this belief. Determination of vitamin and mineral content could be made by a well-trained chemist with the proper equipment.

The services of a chemist are also essential in connection with the efficient planning of experiments and interpretation of results of research from investigations involving soil and plant relationships. Information on the levels of available fertilizers and minor elements in soils would make it possible to extend experiment station results without detailed fertilizer trials on each soil area.

High moisture content of cereal grains due to the high humidity prevailing during the harvest season presents a problem of developing a method so these grain crops can be harvested and stored without heavy losses from spoilage. If the recommended increase is approved, it is proposed to initiate investigations at the Fairbanks station on the development of a practical and inexpensive method of using forced air and heat to lower the moisture content of grains before storage. It is estimated that $500 will be required for this item.

The most pressing need of the Alaska station is for well-trained technical specialists. The present staff, consisting of only an agronomist, a plant breeder, a dairy husbandman, a biologist, two animal husbandmen (one animal husbandman is superintendent of the station at Fairbanks and the other is superintendent at Matanuska. As superintendents, these men must devote considerable time to the management of the station farms.) and a part-time entomologist, is insufficient to cover the many problems needing attention. The efficiency of the above technical workers would be greatly increased by the employment of a well-trained chemist to provide information on the problems indicated in this justification, as well as provide essential supplementary chemical information on currently active investigations. It is estimated that the services of a well-trained chemist and the necessary equipment for chemical research will cost approximately $6,000.

Items listed in this justification are the result of first-hand observations and discussions with leading farmers, research and extension specialists, and Territorial officials regarding the agricultural problems most needing immediate attention.

Authorization: The Alaska Station Act of June 20, 1936, extends to Alaska the benefits of the Adams and Purnell Acts and authorizes appropriations beginning at $5,000 in 1937 and increasing each year until 1947 when the authorized appropriation is $37,500, which is one-half of that provided for each State under the Adams and Purnell Acts. The following tabulation indicates the amounts authorized and appropriated beginning with the fiscal year 1939:

Fiscal Year	Authorized by Act of June 20, 1936	Budget Estimate	Appropriation
1939	$10,000	$10,000	$8,750
1940	12,500	10,000	8,750
1941	15,000	10,000	10,000
1942	17,500	10,000	10,000
1943	20,000	10,000	10,000
1944	22,500	22,500	22,500
1945	27,500	22,500	22,500
1946	32,500	32,500	27,500
1947	37,500	37,500	

The Alaska Act of June 20, 1936, which extends to the Territory of Alaska the benefits of the Adams Act and the Purnell Act contains a proviso in Section 2, as follows:

> "That no appropriations shall be made under this Act until annually estimated as to funds and amounts by the Secretary of Agriculture, the estimates to be based upon his determination of the ability of the Territory of Alaska to make effective use of the funds in maintaining agricultural experiment stations."

It has been determined by the Secretary of Agriculture that the amounts included in this estimate can be used effectively by the Territory of Alaska during the fiscal year 1947 in maintaining agricultural experiment stations.

(Continued on next page)

WORK UNDER THIS APPROPRIATION

General: The several appropriations under "Payments to States, Hawaii, Alaska, and Puerto Rico for agricultural experiment stations" represent the Federal Government's support to the State, Territorial, and Puerto Rican agricultural experiment stations which are established as departments in the land grant colleges pursuant to the provisions of the Hatch Act of 1887.

The primary function and obligation of the State agricultural experiment stations is to meet the needs of the farmers of the several States through study and solution of State and local agricultural problems. This function is expressed in the Hatch Act of 1887 and the Adams Act of 1906 which specify that the investigations conducted shall be with "due regard to the varying conditions and needs of the respective States and Territories."

In addition to their function of serving State and local needs, the research programs of the State stations, to be most effective, include participation in regional and national programs. Research programs of the State stations and the research of the United States Department of Agriculture are supplementary and interdependent, the Department of Agriculture having primary responsibility concerning the agriculture for the country as a whole, whereas the State stations have responsibility regarding agriculture primarily in relation to local needs and requirements in the various climatic and type-of-farming areas throughout the country.

Progress and Current Program:

Facilities and resources of the State agricultural experiment stations in 1945 were again taxed to the limit to keep pace with the demands for facts needed to assure necessary production of agricultural products and their effective use to promote the war effort. Each of the stations contributed important new information helpful in solving local problems and did its part along with Federal agencies in assembling and interpreting data essential in the formulation of regional and national programs. The continued high level of farm production achieved has been aided substantially by the steady output of timely research information by the experiment stations.

Evidence that the stations have continued to keep their research programs up to date in response to the most pressing needs for information is found in the rapid turn-over of projects. During the year 516 new and revised research projects were undertaken with major support from the Federal-grant funds and 493 projects were completed or discontinued. All told, 3,434 Federal-grant fund projects and 4,761 State fund projects were active during the fiscal year 1945. The new findings were put to work promptly by means of letters, news releases, radio, the telephone, at meetings, and in mimeographed and printed publications.

As an example of the public demand for research information developed by the stations, the requests of New York farmers for publications of the State (Geneva) station may be cited. During the year 73,176 copies of various bulletins and circulars were sent to persons who had asked that their names be placed on mailing lists to receive publications on particular subjects. In addition 64,760 copies were mailed in response to individual requests. A total of 30 bulletins and circulars and 4 numbers of the journal "Farm Research" was published during the year. Some of these were reprints of earlier publications still in heavy demand.

Especially noteworthy progress was made by the stations in cooperative investigations aimed at getting the largest possible returns for the money spent. Research in cooperation with the Department of Agriculture was carried on under 1,151 formal memoranda of understanding. In addition, there was much informal teamwork between these agencies and interstate cooperation not recorded by this Office. This saved many man-hours of time by technical workers, reduced costs by using equipment and land available at the stations, and speeded up results. Many studies cooperative between groups of States and the Department produced findings helpful in solving local problems and of benefit to major regions. Regional groups of experiment station directors and technical workers were active as never before in planning the most effective ways of working together on common problems and a number of joint reports were issued or begun.

The national cooperative studies on conservation of the nutritive values of foods yielded results of importance locally and nationally. More than 100 progress notes covering the results have been released to date. One or more foods are being studied by each of the State stations.

Effective progress was made by the north central group of State stations and the Department in cooperative marketing studies and joint publications were issued. Postwar uses and adjustments in the cotton industry are receiving major attention in the research and planning of the southern group of directors. A survey of cooperative research in progress among the 12 stations of the northeastern region showed work on 37 different subjects with 142 instances of participation by individual stations. This was in addition to cooperation with Federal agencies and States outside the region.

Plans were developed by the stations in important dairy States of the northeastern and north central regions for a coordinated research program involving economic problems in dairy production and marketing.

All States contributed as formerly to the development and interpretation of information needed in setting up food production requirements and in future planning.

Reviews of the major findings under the work of 53 experiment stations on 3,434 Federal-fund projects will be available in the annual report to Congress on the agricultural experiment stations for 1945 and some 150 examples of research results from this report are now available in mimeographed form. By way of illustration, a few selected items are cited here, as follows:

The prompt release by the experiment stations of new, improved varieties of plants has helped farmers meet production goals. Many were developed in cooperation with the Department. For example:-- Empire cotton by the Georgia station with average increase of $22 per acre--400 tons of breeders' seed now available; Camellia, Traveller, and Clinton, superior disease-resistant oat varieties, by the Louisiana, Arkansas, and Iowa stations, respectively--Clinton outyields other varieties by 16 bushels per acre; Blackhawk, Wasatch, and Mida wheats by the Wisconsin, Utah, and North Dakota stations boosting yields in these and adjoining States; and new barley varieties, Mars (Minnesota station) better yielding by 35 percent than standard varieties in southern Minnesota, and Sunrise (North Carolina station) potentially able to increase North Carolina barley production by 200,000 bushels. Because of the higher prices it commands, the Halehaven peach, developed by the Michigan station, added $500,000 to the income of Michigan growers in 1945. New hybrid popcorns from the Indiana and Kansas stations cooperating with the Department outyield open-pollinated varieties by 9-68 percent, and because of superior qualities are in great demand--150,000 pounds of hybrid seed grown in Indiana in 1944.

Promising new tomato hybrids developed or tested by a number of stations are giving increased yields ranging up to 52 percent. Minnesota station Earliana x Pritchard hybrids produced 33 percent more than the best varieties and would add a million dollars annual value if planted throughout the State. Seed production remains to be worked out.

Virginia Victory beans, described by a farm journal as "the most promising bean of this generation," were under trial in 1945 by more than 9,000 gardeners, commercial growers, and seedsmen in 39 States, Hawaii, and Australia. The Virginia station developed them over the years by crossing the Kentucky Wonder bean with rust-resistant varieties.

Through extensive investigations by the stations, a number of new chemicals are finding uses with old materials for controlling insects and diseases. Based on Illinois station studies two new organic dusts, Arasan and Thiosan, are replacing formaldehyde for onion smut control in the Chicago area where 80 percent of the onion sets produced in the United States are grown. The formaldehyde treatment used there for the past 25 years is slow and laborious. The new treatment is two or three times faster and equally effective.

So far, insecticides have not been fully effective against the Oriental fruit moth, a destructive peach pest. Parasites have been used successfully but the cost of rearing them has been high. The California station has solved this problem for the State and Nation by developing an "assembly line" method of rearing the parasites on the potato tuber moth at a cost of only 30 cents per thousand. Nearly 20 million parasites were produced and liberated in California in 1944 and a larger number was estimated for release in 1945.

Ways of reducing labor requirements have been particularly valuable in view of the farm labor shortage. Florida station studies showed celery growers how to cut labor costs almost one-half. The Washington station found that turkey producers with flocks of 2,700 birds used only 0.72 man hours of labor per bird. With 1,230 birds, the labor requirement was almost doubled at 1.34 man hours.

Missouri farmers of the Ozark region are adapting a system of pasture management for getting rid of Lone Star ticks worked out through research of the Missouri station. Two pastures are used, one is grazed until June 15 then kept free of stock by grazing the second pasture until the first killing frost. Repeating this practice the second year starves out the seed ticks. Then the pastures are reversed and the second one largely freed of ticks by restricted grazing.

Deficiencies in minor elements have limited crop yields in many areas. Findings of the stations that small additions to the soil of such elements as boron, magnesium, manganese, zinc, and copper result in large yield increases are leading to general use by farmers of the needed element in particular areas. Thus Vermont farmers are beginning to apply boron widely over the State. One community used a carload or enough to treat 50,000 acres. The studies of the Vermont station extending over a dozen or more years and covering tests of 46 soils to a 3-foot depth have shown that small amounts of boron greatly increase production and quality of a number of crops, including alfalfa, apples, potatoes, clover, sweet corn, tomatoes, cabbage, lettuce, beets, beans, and turnips. For example, 40 pounds of borax gave 3 more tons of alfalfa hay during a 3-year period. The borax cost $1.20, the extra hay was worth $36. Vermont fruit growers are using it to prevent internal cork in apples.

Financial Support:

The Federal-grant funds for the State agricultural experiment stations are authorized by the Hatch Act, the Adams Act, the Purnell Act, and Title I of the Bankhead-Jones Act of June 29, 1935.

The several appropriations under "Payments to States, etc." provide annually for each State agricultural experiment station $15,000 under the Hatch Act; $15,000 under the Adams Act; $60,000 under the Purnell Act; and for the fiscal year 1946, $2,663,708 under the Bankhead-Jones Act of June 29, 1935, to the States, Territories, and Puerto Rico, apportioned primarily on the basis of rural population.

In addition to this Federal support, each of the State, Territory, and Puerto Rico experiment stations receives financial support from the State in which located. For a number of years, the support received by these stations from non-Federal sources has exceeded Federal appropriations. A summary of funds available to State stations during the period 1941 through 1945 are shown in Table II.

TABLE II

SUMMARY OF FUNDS AVAILABLE TO STATIONS, 1941 - 1945

Fiscal Year	Federal	Non-Federal	Total
1941	$6,862,500	$15,571,050	$22,433,550
1942	6,926,207	15,572,195	22,498,402
1943	6,926,207	17,277,667	24,203,874
1944	7,001,207	19,939,102	26,940,319
1945	7,001,207	21,080,979	28,082,186

Total amounts available to the various State and Territorial agricultural experiment stations from both Federal and non-Federal sources during the fiscal year 1945 are indicated on the following table:

(Continued on next page)

TABLE III - Funds Available to Stations, Fiscal Year 1945

Station	Federal	Non-Federal	Total
Alabama	$ 172,695.12	$ 548,446.61	$ 721,141.73
Alaska	39,752.44	48,565.67	88,318.11
Arizona	103,285.16	158,486.96	261,772.12
Arkansas	153,983.20	227,661.29	381,644.49
California	171,893.64	1,739,551.33	1,911,444.97
Colorado	112,430.96	311,318.97	423,749.93
Connecticut, State	56,253.66	202,685.00	258,938.66
Connecticut, Storrs	56,253.66	63,188.50	119,442.16
Delaware	95,189.96	139,218.80	234,408.76
Florida	124,782.16	897,870.47	1,022,652.63
Georgia	177,522.92	261,625.91	439,148.83
Hawaii	99,186.40	201,568.75	300,755.15
Idaho	104,219.84	101,625.28	205,845.12
Illinois	176,736.52	684,241.92	860,978.44
Indiana	152,900.44	1,107,346.03	1,260,246.47
Iowa	154,854.64	754,819.87	909,674.51
Kansas	140,050.96	479,815.61	619,866.57
Kentucky	171,533.32	295,238.70	466,772.02
Louisiana	146,502.80	349,767.49	496,270.29
Maine	110,692.16	193,851.78	304,543.94
Maryland	120,259.72	235,269.85	355,529.57
Massachusetts	108,674.92	221,283.14	329,958.06
Michigan	163,566.60	289,700.50	453,267.10
Minnesota	147,269.04	547,513.95	694,782.99
Mississippi	162,651.40	550,710.65	713,362.05
Missouri	166,967.80	332,295.16	499,262.96
Montana	105,503.16	289,826.71	395,329.87
Nebraska	128,776.60	264,587.60	393,364.20
Nevada	92,734.64	35,210.06	127,944.70
New Hampshire	98,507.40	38,367.73	136,875.13
New Jersey	121,260.32	588,283.01	709,543.33
New Mexico	104,516.00	124,739.21	229,255.21
New York, Cornell	166,030.40	896,064.75	1,062,095.15
New York, State	18,447.84	460,070.07	478,517.91
North Carolina	196,085.56	259,407.49	455,493.05
North Dakota	114,675.76	223,285.91	337,961.67
Ohio	183,717.64	1,321,305.62	1,505,023.26
Oklahoma	158,450.84	498,598.69	657,049.53
Oregon	112,790.32	472,438.30	585,228.62
Pennsylvania	225,322.64	384,651.49	609,974.13
Puerto Rico	143,213.24	223,372.09	366,585.33
Rhode Island	92,449.04	33,651.01	126,100.05
South Carolina	149,464.96	603,055.00	752,519.96
South Dakota	114,432.44	138,006.25	252,438.69
Tennessee	167,136.04	184,332.11	351,468.15
Texas	239,364.76	1,223,239.59	1,462,604.35
Utah	100,503.68	159,764.84	260,268.52
Vermont	100,471.60	32,042.02	132,513.62
Virginia	161,144.56	215,672.35	376,816.91
Washington	123,254.64	414,132.77	537,387.41
West Virginia	145,859.16	169,536.88	315,396.04
Wisconsin	150,224.88	751,348.00	901,572.88

(b) Administration of Grants and Coordination of Research with States

Appropriation Act, 1946		$153,600
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+21,000
Total anticipated available, 1946		174,600
Budget estimate, 1947		173,000
Change for 1947:		
Overtime decrease	-2,600	
Increase	+1,000	
		-1,600

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Administration of Federal-grant funds for State and Territorial agricultural experiment stations, coordination of research work of the State and Territorial stations, coordination of this research with that of the Department, and administration of Department insular stations	$144,646	$172,000	$173,000	+$1,000
2. Overtime pay	20,307	2,600	- -	-2,600
Covered into Treasury as miscellaneous receipts, Public Law 529	10	- -	- -	- -
Unobligated balance	11,206	- -	- -	- -
Total available	176,179	174,600	173,000	-1,600
Anticipated supplemental	- -	-21,000	- -	
Total estimate or appropriation	176,169	153,600	173,000	

INCREASES OR DECREASES

The net decrease of $1,600 in this item for 1947 consists of a decrease of $2,600 for overtime, and an increase of $1,000 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only part of the fiscal year 1946.

CHANGE IN LANGUAGE

The sole purpose of the proposed language change, which involves relocating the position of the limitation on expenditures for personal services in the District of Columbia, is to simplify and shorten the language of the item.

WORK UNDER THIS APPROPRIATION

Objective: To represent the Department in (a) the administration of the Acts of Congress authorizing appropriations for the support of State and Territorial agricultural experiment stations in the several States, Hawaii, Alaska, and Puerto Rico (Hatch Act, Adams Act, Purnell Act, and the Hawaii, Alaska, and Puerto Rico Station Acts); and (b) the administration of the Federal Experiment Station in Puerto Rico.

Plan of Work: Administration of the Acts granting funds to States and Territories involves supervision of the funds, close advisory relations with the stations as to research for which the funds are expended, annual examination of the work and expenditures of each station, assistance to the State stations in working out programs for cooperative effort to avoid duplication, assistance to Federal agencies in working out cooperation with the States, and preparation of the annual report to Congress on the work and expenditures of the stations, as required by law.

Funds made available under the Federal-grant acts are warranted "to the treasurer or other officer duly appointed by the governing boards of said colleges to receive the same * * *" to carry forward the work of the experiment stations in accordance with the requirements of the respective acts, as, for instance, the Purnell Act which provides that:

> "The funds appropriated pursuant to this Act shall be applied only to paying the necessary expenses of conducting investigations or making experiments bearing directly on the production, manufacture, preparation, use, distribution, and marketing of agricultural products and including such scientific researches as have for their purpose the establishment and maintenance of a permanent and efficient agricultural industry, and such economic and sociological investigations as have for their purpose the development and improvement of the rural home and rural life, and for printing and disseminating the results of said researches."

The Secretary has responsibility for administration of the Federal-grant funds for research and "shall prescribe the form of the annual financial statement required under the above Acts, ascertain whether the expenditures are in accordance with their provisions, coordinate the research work of the State agricultural colleges and experiment stations in the lines authorized in said Acts with research of the Department in similar lines, and make report thereon to Congress."

In accordance with these responsibilities and duties Federal funds paid to the States and Territories are expended largely on research projects submitted to the Office of Experiment Stations for advisory suggestions and approval in advance of expenditures. Programs of projects with proposed expenditures under the Federal funds are submitted by each station for review and approval at the beginning of each fiscal year. Changes and adjustments in work to meet State needs are submitted throughout the year.

To carry out the provisions of the Federal Acts, a representative, or representatives, of the Office visits each of the 50 State stations at least once annually and spends four to twenty-one days reviewing the expenditures and the research under way. In addition, staff members cooperate as specialists with individual stations and regional groups in the development and adjustment of research programs for special fields.

As explained under the heading "Special Research Fund, Department of Agriculture," the Office also has the responsibility for the administration of the payments to States authorized by Title I of the Bankhead-Jones Act of June 29, 1935.

Examples of Current Activities: The current program of administering Federal-grant funds involves a responsibility of arranging for prompt, effective cooperation among the States and of the State stations with the Department of Agriculture and with other agencies as needed to attack most effectively problems arising under the changing conditions now faced and in prospect.

The Office of Experiment Stations has continued to maintain close advisory relationships with the State agricultural experiment stations on adjustments in their research programs to concentrate on research problems needing immediate solution and the redirection or termination of older studies. A large percentage of these problems are specific and as a result are of a relatively short-term duration. This is evidenced by the fact that of the total of 3,434 studies undertaken during the fiscal year 1945, 516 were under new projects; 134 projects were revised; and 493 projects were completed or discontinued. Each revised project and each project continued without change was reviewed during the year by the staff of this Office as to intent, adequacy, and progress.

Any problem of more than local interest was reviewed in cooperation with other agencies concerned for correlation of the research with work being conducted by other State stations or by other agencies so as to avoid duplication of effort and to promote accurate research results through cooperative and joint attack on problems extending beyond the boundaries of any one State. The extent of this cooperation is indicated by the 1,151 active formal cooperative memoranda of understanding in effect during the year between State stations and between State stations and other agencies. Seventy other

cooperative documents are in effect but temporarily inactive because of loss of personnel to the armed forces, pressure of work on problems of immediate interest, and because of other temporary conditions. Each of these memoranda of understanding was approved by the Office of Experiment Stations before becoming operative.

The Office continued publication of Experiment Station Record as a means of aiding and coordinating research. Nearly 7,000 technical abstracts on agricultural subjects were prepared, edited, indexed, and published in this periodical during the fiscal year 1945 as a means of focusing attention of research workers in the State stations and in the Department on current published results of research, thus facilitating project planning, the development of cooperation, and the coordination of research effort. This abstracting service by the Office of Experiment Stations saves time of thousands of research workers by bringing to their attention current research findings without their having to review the hundreds of publications involved.

The Federal Experiment Station in Puerto Rico is under the administrative supervision of the Office of Experiment Stations. The research program is aimed at increasing the production of strategic agricultural crops of value to the United States and improving practices to make the growing of tropical crops of greater economic benefit to the people of Puerto Rico. The work is carried out in cooperation with agencies concerned with the Inter-American program and the Government of Puerto Rico. The activities of the Station are described in more detail in a separate statement under the appropriation for the Station.

The Office served as a clearing house for information and service on behalf of the State experiment stations, and on request, for agencies of the Department. The calls upon the Office for such assistance in some form or other were numerous. Problems and questions involved in production and distribution of agricultural products were given priority.

The Office worked with agencies of the Department and all State experiment stations in continuing the Nation-wide studies of farm production, including results from experimental work, as a basis for production goals in total and allocation by crops and production areas. Participation of the stations involved adjustments in their Federal-grant fund as well as State fund programs.

In continuation of work begun in 1944, the Office obtained information relating to current and proposed investigations by the State agricultural experiment stations on the use of potatoes in the feeding of livestock. The information was assembled and issued in mimeographed form for use by the stations and the agencies of the Department directly concerned.

For many years the Office has issued annually a mimeographed list of projects and publications covering experiment station research in home economics. Because of the increasing consumer interest in foods, this compilation has been expanded to include as far as possible all State experiment station research pertaining to foods and nutrition of interest to the consumer regardless of the station department or division involved.

The Nation-wide study of butter as a source of vitamin A in the diet of the people of the United States was completed to the point of publication during the year. The work was begun in 1942 upon recommendation of the Committee on Food and Nutrition of the National Research Council, with 19 State agricultural experiment stations, the Bureau of Dairy Industry, and the Office of Experiment Stations cooperating. Analyses were made of butter obtained in different seasons and areas through the usual trade channels. A brief discussion of the results is presented in a government publication entitled "Vitamin A in Butter", with a more detailed technical report to follow.

Assistance was continued to representatives of other countries in making arrangements for obtaining information from the experiment stations through personal visits and otherwise, and the Office also helped to further the requests of other countries for experiment station publications.

The coordination of research among the experiment stations and between the stations and Federal agencies was advanced by discussions with participating groups of administrators and research workers. Thus, for example, the Chief of the Office participated with groups of station directors of the four major regions of the United States in discussions relating to continuation and extension of cooperative research among the States and with regional laboratories of the Department. Similarly, the subject matter specialists of the Office participated with research workers of the stations in the planning of cooperative studies by various groups of States. Included were such subjects as economic problems in dairy production in the Northeastern and the North Central regions, range cattle improvement in the Great Plains area, breeding of chickens for broiler production, jack stock and mule production, and plant diseases and insect control studies with special attention to research with new fungicides and insecticides. Particular attention was given to work with directors and station staff members in the major cotton producing States directed to summarizing existing information and planning future research in all phases of the cotton industry, including production, processing, utilization, and marketing.

The Chief of the Office and the subject matter specialists in foods and nutrition continued to give major attention to the coordination and promotion of the national cooperative studies on the conservation of the nutritive values of foods in processing, marketing, storage, and cooking. The more than 100 progress notes covering the results of these studies which have been released to date by the stations have been immediately helpful in meeting problems relating to the feeding of the armed forces and civilians. Practically all of the State stations are participating in these studies by investigating one or more foods.

(Continued on next page)

(c) Federal Experiment Station, Puerto Rico

Appropriation Act, 1946	$99,375
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945	+9,000
Total anticipated available, 1946	108,375
Budget estimate, 1947	170,200
Change for 1947:	
Overtime decrease -1,175	
Increase +63,000	+61,825

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Federal Experiment Station, Puerto Rico	$98,942	$107,200	$170,200	+$63,000 (1)
2. Overtime pay	8,082	1,175	- -	-1,175
Covered into Treasury as miscellaneous receipts, Public Law 529	20	- -	- -	- -
Unobligated balance	30	- -	- -	- -
Total available	107,074	108,375	170,200	+61,825
Anticipated supplemental	- -	-9,000	- -	
Total estimate or appropriation	107,074	99,375	170,200	

INCREASES OR DECREASES

The net increase of $61,825 in this item for 1947 consists of a decrease of $1,175 for overtime, and the following:

(1) An increase of $63,000 composed of:

(a) An increase of $62,500 to cover construction of needed facilities at the Federal Experiment Station in Puerto Rico:

Objective: To construct seven new dwellings to replace existing houses considered unsafe for further occupancy, an incinerator for disposing of diseased plant material, and a headhouse for the greenhouse unit at the Federal Experiment Station in Puerto Rico.

The Situation and Need: The estimate for an increase of $62,500 includes construction of seven new dwellings for members of the technical staff. It is contemplated that these seven new dwellings would replace seven of the present dwellings which are in need of complete overhauling. All but one of these dwellings were constructed prior to 1925. The condition of these houses is such that it would be more economical to replace them than to attempt to repair them.

The Puerto Rico station being located in the Tropics has many problems of maintaining adequate physical plant facilities not normally found in the continental United States. The station experiences very heavy rains during a portion of the year and extreme heat and dryness during other portions. Earthquakes and high winds, sometimes of hurricane proportions, are not uncommon. Furthermore, all wooden construction of such soft woods as pine is subject to termite damage and to dry rot. Because of this combination of conditions, a new frame house is estimated to need complete overhauling at least once every six years.

The serious state of disrepair which renders some of the present houses unsafe requires that prompt consideration be given to their replacement. Housing facilities must be made available for the scientific staff of the station since a continental American cannot rent, in the City of Mayaguez, a place affording the privacy and sanitation customary in the States. Without housing facilities it would be difficult, if not impossible, to recruit or maintain a competent technical staff.

In June, 1944, the architect for the Government of Puerto Rico after an inspection of staff houses stated that "in the event of a hurricane, I would recommend that staff members be evacuated from these buildings because they will certainly suffer collapse in part." He further stated "the electrical systems present a fire hazard in the wooden houses * * * the kitchens and baths are substandard * * * pipes and fixtures need replacement * * * the station housing has reached the point where the logical and economical step is replacement and not repair."

The station has available for immediate use detailed plans, specifications, and blueprints for construction of these dwelling units. The dwellings would be built of reinforced concrete with concrete slab roofs, with tile floors, and with up-to-date plumbing and electrical equipment. This type of house would be relatively safe in the event of earthquakes or hurricanes, would reduce to a minimum the necessity for repair work because of dry rot or infestation by termites, and would provide safe and sanitary living conditions for continental American staff members and their families.

In addition, the station has need for a headhouse for its greenhouse unit. The Puerto Rico station has one of the largest collections of tropical plants in the Western Hemisphere. As a result, a large amount of greenhouse work must be conducted. The headhouse for the greenhouse unit is necessary for proper conduct of the greenhouse work.

The station also has need for a well constructed incinerator. There is more or less constant need for disposal of diseased plant material which must be burned to prevent spread of disease. The station also has considerable amounts of garbage and other refuse which require proper disposal for sanitary reasons.

Plan of Work: The construction of dwellings provided for in this increase would be performed under contract with a local contractor. The architect and the engineer employed by this Office would be responsible for adherence to contract specifications. The construction of the incinerator and headhouse for the greenhouse unit would be handled by force account labor.

According to the latest information from Puerto Rico, cement, sand, gravel, stone, reinforcing steel, pipe, glass, and tile are available for this construction. These represent the major portion of the materials required. It is felt certain that plumbing fixtures and electrical fixtures will be available by the time they are needed.

(b) an increase of $500 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only part of the fiscal year 1946.

CHANGES IN LANGUAGE

The estimates include proposed changes in the language of this item, as follows (deleted matter enclosed with brackets, new language underscored):

> Federal Experiment Station, Puerto Rico: To enable the Secretary to establish and maintain an agricultural experiment station in Puerto Rico, including the preparation, illustration, and distribution of reports and bulletins, [$99,375; and the Secretary is authorized to sell such products as are obtained on the land belonging te the agricultural experiment station in Puerto Rico and the amount obtained from the sale thereof shall be covered into the Treasury of the United States as miscellaneous receipts] $170,200, of which not to exceed $56,000 may be expended for construction of seven buildings.

The first change deletes the language which has been carried in the annual appropriation act for a number of years authorizing the sale of products resulting from work of the Puerto Rico station. This language has been necessary because such authority is normally not implied.

However, it is now considered that Section 14(b) of the Surplus Property Act of 1944 (Public Law 457, approved October 3, 1944) provides adequate basic legislative authority for the sale of products of experimental operations conducted by the Department of Agriculture. While the Surplus Property Act expires by its terms at the end of 3 years following the date of cessation of hostilities in World War II, the Department, at the end of such period, could secure an appropriate waiver from the Treasury Department (Procurement Division) to continue the sale of products at the Puerto Rico station in much the same manner as now exists with respect to the products of some of the Department's other experimental operations.

(Continued on next page)

WORK UNDER THIS APPROPRIATION

Objective: To conduct agricultural research investigations with a view to increasing the production of strategic agricultural crops of value to the United States and of improving practices to make the growing of tropical crops of greater economic benefit to the people of Puerto Rico. During the war period, the station concentrated on problems of immediate concern such as production of rotenone-producing plants; the growing of Cinchona, from which quinine is obtained; and food crops.

Examples of Past and Current Activities:

Insecticidal Crop Investigations. Rotenone, an insecticide toxic to insects but harmless to man and domestic animals, continues to be a scarce strategic material. This product was formerly obtained from the Far East and in small quantities from South America.

It was reported last year that some 1,385,927 plants and cuttings of Derris were distributed throughout Latin America to increase the plantings of this rotenone-producing crop in the Western Hemisphere. During the past fiscal year, this figure has passed the two and one-half million mark. Commercial plantings of this crop in the Western Hemisphere have been carried out in cooperation with the Foreign Economic Administration, the Office of Foreign Agricultural Relations, and with private companies and individuals.

The selection amd multiplication of high-yielding rotenone stock of Derris originally obtained from Sumatra have received special attention during the year. The value of the product is based on the percentage of rotenone present in the dry root. One of the main objectives has been to increase the quality of plant material available. Over 35,000 plants of high-yielding clones, some running over 9 percent rotenone as compared to the average commercial material of 5 percent, have been planted in the field and are being multiplied as rapidly as possible for further distribution. This project also included the crossing of promising varieties and strains of Derris to increase root yield and root quality. Such improvement through use of the highest quality available stock appears essential to the establishment of Derris as a profitable crop in the Western Hemisphere.

In addition to increasing the available supply of planting material, investigations were conducted to find new and better methods of propagation and to improve on cultural practices. Investigations in methods of propagation showed that the top bud of Derris cuttings must be directed up for best rooting and top growth and that the basal cut on cuttings should be made at least 3 to 4 cms. below the basal bud for best rooting. Experiments on the best type of cutting to use indicated there was little difference in root quantity or

quality after 14 months of growth regardless of the type of cutting originally used. Early differences tended to be ironed out as the plant approached maturity. Derris root is ordinarly not harvested until 26 months after planting. Studies on the grafting of high rotenone yielding Derris plants on to low yielding stocks which were known to be heavy root producers did not result in an increase in rotenone.

Investigations of other plants of possible insecticidal value were continued and the common tropical plant, Mamey, continued to be the only promising one found to date. The seeds of Mamey were found to be highly toxic to a number of common insects and comparable to rotenone in the field control of certain insects. It appears to have definite value as a local and cheap source of an insecticidal material for the farmer.

Drug Crop Investigations. The bark of various species of Cinchona is the commercial source of the drug quinine. Prior to the war, almost the entire production of quinine was controlled by the Dutch and grown in Java. While quinine has been successfully synthesized and substitutes are available, none of these are readily available nor can they be used except under the care of a competent physician. Millions of people throughout the tropical world will continue to depend upon the natural sources of quinine for the preparation of local prophylactics and preparations such as "totaquina" made directly from the crude bark.

The work of the Station has concentrated on the development, selection, and maintenance of high-yielding strains of Cinchona and on the solution of cultural problems. In cooperation with the Defense Supplies Corporation, a project was set up to propagate and grow the highest known yielding strains of Cinchona which were flown out of the Philippines just prior to the Japanese occupation. Several thousand of these particular plants are now well established in the mountains of Puerto Rico and will become a permanent source of future breeding and planting material.

The Cinchona plant is highly selective as to its environmental conditions. The secrets of its successful cultivation have been carefully guarded by the Dutch in order to maintain and curtail operations and monopolize the production of quinine. Problems in the growing of seedlings and nursery stock have been satisfactorily solved and it can be stated that sufficient information is now available on these two phases in the propagation of Cinchona to insure material for field plantings. We are just entering the second phase of the problem, that is, the establishment and successful growing of Cinchona in the field.

Experiments on the transplanting of Cinchona from the nursery to the field have indicated that severe cutting back of the leader at the time of transplanting results in the highest percentage of field establishment. Experiments on field fertilization, cover crops, light, and moisture requirements are being undertaken. Since Cinchona is a tree crop and is not normally harvested until at least eight years of age, this type of investigation must by necessity be of long-time duration.

The results of the investigations being conducted in Puerto Rico are being made available to other Government agencies interested in the establishment of Cinchona in the Western Hemisphere.

Food Crop Investigations. Considerable emphasis is being placed upon the production of food crops in Puerto Rico. This problem deserves special attention for several reasons: (1) Puerto Rico has a one crop agricultural system, namely, the production of sugarcane. It has been the policy to produce sugar and import low value foods such as rice and beans which are the staple diet of the Puerto Rican people. Postwar adjustments may considerably alter the production of sugar and it will become necessary to produce other crops, perhaps even for subsistence of the population; (2) there is little interest on the part of the average Puerto Rican laborer to produce any of his food. This has been brought about in part due to lack of proper varieties for growing in the Tropics, and to the low production of most food crops because of insect and disease damage. The selection of varieties resistant to insects and diseases would greatly simplify the problem; (3) there will be a continuing and increasing need for information on food crops adapted to tropical areas not only in the Caribbean but in the Pacific in order to provide an adequate food supply for the people of these areas; (4) with increased transportation facilities, the production of vegetables in Puerto Rico offers a distinct and promising possibility for the export of vegetable crops during the winter months to the continental United States.

An extensive program testing some 24 kinds of vegetables and as many as 10 or 12 varieties of each type has been undertaken. The latest bulletin issued by the station on vegetables was in 1907. An Extension Service bulletin on home gardening was issued in 1936, but both publications are in urgent need of revision to bring them up to date and to include the many varieties which have been developed in recent years and which are known to be resistant to many diseases and insects.

The Station has cooperated extensively in the production of seed for distribution in the food production program. During the year, 4,886 pounds of U.S.D.A.-34 sweet corn; 4,925 pounds of Seminole soybeans; and 24,610 pounds of yams, three food crops on which the Station has worked experimentally, were distributed. The U.S.D.A.-34 sweet corn, a variety developed by the Station several years ago, has attained particular prominence during the past year. It has become widely distributed throughout the tropical islands of the Pacific occupied by our military forces. Shipments have been transported by air from Puerto Rico to such points as New Guinea, Guadalcanal, and other

islands of the Pacific, in order to provide fresh sweet corn for the armed forces. U.S.D.A.-34 is the only variety sweet corn particularly adapted to tropical conditions.

The selection of better and more promising varieties of mangos and avocados introduced by the station over past years has continued to receive attention. The avocado is one of the best local sources of protein in the Tropics. It is a cheap and readily obtainable food but unfortunately production is confined to a rather narrow season. By introduction and selection, it has been possible to produce trees which bear fruit at a time when the local varieties are normally out of production. The propagation and breeding of these new selections will greatly increase the period of time over which this valuable fruit may be available to the local people.

Plant Introduction and Propagation. The collection and maintenance of a plant introduction garden has been one of the major activities of the station since its establishment. The number of plants introduced is now nearly eight thousand and represents species from all over the tropical world. The value of such a collection has again been shown during the past year with the result that one species brought from Egypt many years ago has proven to be of interest and perhaps of great importance in the control of a serious tropical disease, schistosomiasis, or liver fluke. The particular plant is known as Balanites aegyptiaca and the fruit of this plant has been found to be highly toxic to snails, the alternate host of this and other tropical diseases.

In Puerto Rico, as in many other tropical areas, schistosomiasis is one of the most serious tropical diseases. Preliminary investigations have shown that the propagation of this plant, Balanites, around the edges of reservoirs, which are focal points of infection, results in a reduction of the snail population. It is also known that the fruits and other parts of the plant are highly toxic to the intermediate stages of the disease which pass from man to snail and snail to man.

The large collection of tropical plants at the station continues to provide a source of plant material for testing as to possible insecticidal value. Thousands of plant species are used by the natives of various tropical countries in the killing of fish and the control of insects but few of these have been thoroughly tested scientifically as to their actual value.

The plant collections at the station have afforded large quantities of planting materials which have been distributed particularly to the military authorities for planting on bases throughout the Caribbean area. Some 83,900 rooted plants, both economic and ornamental, were distributed during the year. In addition, large quantities of cuttings, seeds, and grass sod were also provided. Continual requests for planting material were received from many countries in Latin America.

Considerable work was carried on with Manila grass, Zoysia matrella, a promising new lawn grass for the Tropics and for the southern United States. This grass is being planted and used extensively on airway strips. It has been impossible to produce seed in the continental United States and the usual propagation is by means of rooted clumps. In Puerto Rico it has been possible to obtain seed and studies on production, viability, and germination are being carried out.

Control of Insect Pests and Diseases. The Station carries out investigations on many plants of economic and strategic importance. The successful establishment of these plants is often retarded by insect pests and diseases. The storage of seed in the Tropics is a serious problem.

The control of thrips attacking young Cinchona seedlings in the nursery was effectively brought about by the use of a one percent rotenone dust in combination with talc. Bi-monthly application completely brought under control serious infestations of this pest.

The treatment of termite-infested furniture and timbers in buildings with orthodichlorobenzene diluted with an equal volume of a 5 percent solution of commercial pentachlorophenol in light Diesel fuel oil gave excellent control and prevented reinfestation when this solution was injected into the tunnels of the infested wood.

In cooperation with the Bureau of Entomology and Plant Quarantine, shipments of sugarcane moth borer parasites and green scale parasites were received from Brazil to aid in the control of these two serious insect pests. The successful establishment of parasites and predators in Puerto Rico has resulted in their redistribution to the continental United States and to other countries.

During the course of the year, an introduced pineapple mealybug parasite, Hambletonia pseudococcina, was shipped from Puerto Rico to Florida to aid in mealybug control there.

In cooperation with the Bureau of Entomology and Plant Quarantine facilities for the quarantine of introduced plants were maintained and at least one potentially injurious species of mite and several plant diseases are known to have been prevented from becoming locally established through the retention and treatment of such introduced plants in quarantine.

Bamboo Production and Industrialization. The introduction of bamboos from the Eastern Hemisphere which have proved to be resistant to insect attack has resulted in the establishment in Puerto Rico of a new industry based on this crop. The Station has introduced to date some 42 species of bamboos from all over the tropical world and of these some 6 to 8 species show considerable promise for industrial purposes. Several are known to be highly resistant to insect attack which commonly destroys bamboo and prejudices its usage for construction purposes and for furniture manufacture.

In cooperation with the Puerto Rico Development Company, an Insular Government agency set up to develop new industries on the island, there has been started a bamboo furniture industry. Two workshops are in operation and a considerable quantity of furniture has been produced and sold on the local market.

In cooperation with the Soil Conservation Service in utilizing bamboo as a soil erosion crop, experiments have shown that soil erosion on steep hillsides of little or nor value for agricultural crops can be minimized through the planting of bamboo. This crop serves two purposes: (1) it controls erosion, and (2) it brings a profit from land which cannot be utilized for the growing of other crops.

A total of 24,828 bamboo plants were distributed during the year to Government agencies and to private individuals for planting purposes. Studies on the methods of curing bamboo showed that under water curing was not superior to ordinary methods. Older culms were found to be more resistant to insect attack probably because of greater lignification and less starch. The best practical method of curing bamboo thus far has been to stand cut but unpruned culms in the clump for several weeks to dry before removing branches and storing under shelter.

Cooperation With the Government of Puerto Rico. The Government of Puerto Rico has continued to support the work of the Federal Station by annual appropriations, thus making possible close and active cooperation in agricultural research of local importance. This program has been directed principally to work concerned with vanilla, essential oils, and other tropical crops.

The production of vanilla on the island has increased steadily over recent years. The past year's production was some 6,500 pounds of cured vanilla beans and the present year's production will nearly double that figure. Vanilla is a crop which offers additional income to the coffee farmer who is hard pressed with economic difficulties. The most serious factor affecting the production of vanilla in Puerto Rico is a root rot disease. Studies on the control of this disease have shown that nutrition, as well as good drainage and aeration, is a very important factor. On the recommendation of the Station, practically all vanilla growers are now using crushed limestone in combination with their mulching practices as it has been shown experimentally that this practice will greatly reduce the incidence of disease. Experiments on the curing of vanilla have indicated that the temperature of conditioning is an important factor in producing a desirable aroma. It was found that 35° C. was the optimum temperature for best development.

The work on essential oils was concentrated largely on two oils of local interest. The coffee flower absolute, developed several years ago by the Station, has received favorable comment from the perfume trade and commercial production of the oil on the island has resulted. The bay oil industry has been the object of new research in the essential oil field. This industry although established on the island for many years has never received the benefit of any agricultural research. Initial survey data have shown that the oil content of trees throughout the island varies widely from 1.03 to 2.76 percent of oil and there appeared to be an inverse relationship between oil content and rainfall.

Regional tests with Chinese ginger have shown that sandy soils in areas of uniform rainfall give excellent yields. In cooperation with the Extension Service, plantings are being extended and the interest of local farmers in this new crop has been aroused.

(d) Special Research Fund, Department of Agriculture (Allotment to Office of Experiment Stations)

This budget schedule covers obligations under an allotment for administration of payments to States for research under Title I of the Bankhead-Jones Act of June 29, 1935. By decision of the Comptroller General, the amount of this allotment is limited to 2 percent of the Special Research Fund. The details of administration of payments to States are explained more fully under the preceding subappropriation item "(B) Administration of Grants and Coordination of Research with States."

(e) Working Fund (Office of Experiment Stations)

This budget schedule covers obligations under an advance pursuant to Section 601 of the Economy Act of June 30, 1932, for services performed for the Defense Supplies Corporation in connection with the establishment of a permanent source of high-yielding Cinchona seed in Hawaii and Puerto Rico for production of quinine.

(Continued on next page)

STATEMENT OF OBLIGATIONS UNDER SUPPLEMENTAL FUNDS
[1945 and 1946 figures include overtime costs]

Item	Obligations, 1945	Estimated obligations, 1946	Estimated obligations, 1947
Special Research Fund, Department of Agriculture: For administration of payments to States for research under the Act of June 29, 1935	$22,934	$23,991	$23,693
Working Fund, Agriculture, (Office of Experiment Stations)(Advance from Defense Supplies Corporation): Establishment of source of high-yielding Cinchona seed in Hawaii and Puerto Rico	2,203	5,441	2,000
TOTAL, OBLIGATIONS UNDER SUPPLEMENTAL FUNDS	25,137	29,432	25,693

PASSENGER-CARRYING VEHICLES

The estimate for passenger-carrying vehicles for the Office of Experiment Stations contemplates a decrease of $50 ($800 in 1946, $750 estimated for 1947) for this purpose. The total estimate of $1,375 will permit (1) the operation and maintenance of three and (2) the replacement of one vehicle at a net cost of $750 when the estimated exchange allowance is taken into account. No funds are requested for the purchase of additional vehicles.

The Office at the present time has three passenger-carrying vehicles in operation. These three vehicles have traveled approximately 58,000, 50,000, and 52,500 miles at the present time and will continue to be used by the staff of the Federal Experiment Station at Mayaguez, Puerto Rico, where these cars are located.

Experience has indicated that three passenger-carrying vehicles are necessary for proper operation of the Federal Experiment Station at Mayaguez, Puerto Rico. These cars are required to enable technical staff members to conduct official business at experimental locations throughout the island. The station has use of lands for experimental purposes at several widely divergent locations where different climatic conditions are found. Since these vehicles are operated over rough and mountainous roads in Puerto Rico, it is felt that one vehicle, which was purchased in 1940, should be replaced in the fiscal year 1947.

It has been found in the past that it is best to trade in passenger-carrying vehicles in Puerto Rico when they have reached approximately 40,000 to 45,000 miles.

PENALTY MAIL ESTIMATE
Sec. 2, Public Law 364, 78th Congress
(Allotment to Office of Experiment Stations)

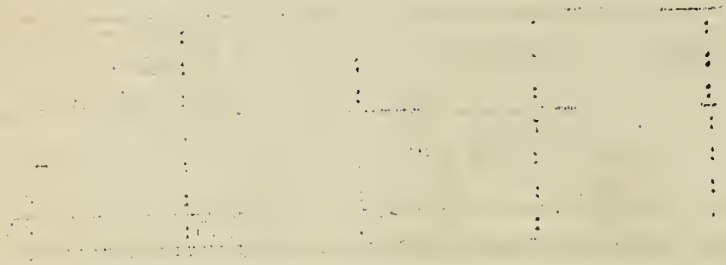
	1945	1946	1947	Increase (+) or Decrease (-) 1947 over 1946
Category 1	$400	$382	$420	+$38
Category 2	174	185	210	+25
Total	574	567	630	+63

Category 1 consists of publications sent to research workers in response to specific requests which include lists of the publications issued by the State agricultural experiment stations "Experiment Station Record" and "Workers in Subjects Pertaining to Agriculture in Land Grant Colleges and Experiment Stations". Also included in this category are publications mailed by the Federal Experiment Station in Puerto Rico consisting of annual reports and current news bulletins and circulars which are of direct assistance in the improvement of tropical agriculture.

The increase of $38 for 1947 will be needed to meet an anticipated increase in requests from farmers and research workers for publications of this Office during the transition period. In 1945 only very careful analysis of each request made it possible for the Office to fill the requests received.

Category 2 consists of the administrative correspondence necessary for carrying on the work and operating functions of the Office; correspondence with the State agricultural experiment stations; and correspondence required in connection with the supervision and operation of the Federal Experiment Station in Puerto Rico.

The increase of $25 for 1947 will be needed to meet the increase in volume of administrative correspondence anticipated due to increases in both Federal-grant funds and also appropriations for administration of these funds proposed in the Budget estimates. Administration of the $346,292 increase in Federal-grant funds plus $336,292 in required State offset funds will, of necessity, require a considerable increase in administrative correspondence.



BUREAU OF ANIMAL INDUSTRY

(a) Salaries and Expenses - Preamble

CHANGE IN LANGUAGE

The estimates include a proposed change in the language of the appropriation preamble, as follows (deleted matter enclosed with brackets):

> For the employment of persons and means in the District of Columbia and elsewhere, including not to exceed [$591,004] $698,246 for departmental personal services in the District of Columbia, for carrying out [, independently or in cooperation with public or private agencies, including individuals,] the provisions of the Act, as amended, establishing a Bureau of Animal Industry, and related Acts, and for investigations concerned with the livestock and meat industries, as follows:

The proposed change in language deletes the words ", independently or in cooperation with public or private agencies, including individuals," for the sole purpose of shortening and simplifying the wording of the item. The clause proposed for deletion is considered surplusage and, therefore, need not be retained in the annual appropriation act, the cooperative work being authorized by the Act of May 15, 1862 (5 U.S.C. 511), establishing the Department of Agriculture, as implemented by the Act of July 24, 1919 (5 U.S.C. 563-564), and Section 101(a) of the Department of Agriculture Organic Act of 1944 (21 U.S.C. 114a). Elimination of the language from the annual appropriation act will not--in any way--change the scope or character of the work performed under this appropriation item, or the authority of the Department to cooperate with other agencies, institutions, organizations, or others in the conduct of such work.

(Continued on next page)

(b) Animal Husbandry

Appropriation Act, 1946		$840,000
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+95,000
Total anticipated available, 1946		935,000
Budget estimate, 1947		994,000
Change for 1947:		
Overtime decrease	-13,610	
Increase	+72,610	
		+59,000

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Swine husbandry investigations	$155,697	$147,326	$148,455	+$1,129 (1)
2. Sheep and goat husbandry investigations	145,660	167,107	168,385	+1,278 (1)
3. Horse and mule husbandry investigations	36,474	44,215	44,533	+318 (1)
4. Beef cattle husbandry investigations	183,050	207,072	208,663	+1,591 (1)
5. Dual-purpose cattle husbandry investigations	65,331	69,919	70,422	+503 (1)
6. Poultry husbandry investigations	234,594	278,750	280,895	+2,145 (1)
7. Certification of pedigrees of imported registered livestock	6,310	7,001	7,047	+46 (1)
8. Facilities in building for large animals	- -	- -	65,600	+65,600 (2)
9. Overtime pay	90,059	13,610	- -	-13,610
Covered into Treasury as miscellaneous receipts, Public Law 529	36	- -	- -	- -
Unobligated balance	10,849	- -	- -	- -
Total available	928,060	935,000	994,000	+59,000
Transferred to "Salaries and Expenses, Office of Information, Department of Agriculture"	+440	- -	- -	
Anticipated supplemental	- -	-95,000	- -	
Total estimate or appropriation (1945 adjusted for comparability)	928,500	840,000	994,000	

INCREASES OR DECREASES

The net increase of $59,000 in this item for 1947 consists of the $13,610 decrease for overtime, and the following:

(1) Increases totaling $7,010 in projects 1 through 7, inclusive, for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(2) An increase of $65,600 to provide additional facilities in building for large animals and adjoining outside area located at the Agricultural Research Center, Beltsville, Maryland.

It is proposed to provide facilities for metabolism and digestion trials with cattle, sheep, and swine, a type of work that has been extremely limited in this country and for which this station has had almost no facilities available, and to complete the facilities for conducting experiments on protein, mineral, and vitamin requirements of farm livestock with these classes of animals under strictly controlled conditions. The improvements are essential to the full and complete use of this building for research purposes as originally contemplated.

More specifically, the feed studies require (1) machinery for grinding, mixing, compressing, pelleting, and other operations, (2) temperature and humidity controlled rooms, and (3) testing apparatus. The metabolism and digestion studies require apparatus suited for use with the different animals, varying from specially designed stalls to delicate measuring instruments, and also of temperature and humidity controlled rooms in part used in common with the feed studies. Other equipment needed to implement nutrition studies are animal operating table, x-ray, and companion equipment. Facilities for handling the animals used in feed and digestion studies include drainage improvements to paddocks, paving of walkways between wings of the building, fencing, animal shelters in paddocks, and manure pit and disposal apparatus. For the installation of the items indicated, space in the large animal building and in the adjacent area are now available.

Estimates of costs of the facilities follow:

Special facilities and equipment for preparation, processing, and storage of feeds used in nutrition research	$20,500
Special facilities and equipment for conducting metabolism and digestion studies on cattle, sheep, and swine	19,000
Animal surgery and x-ray equipment	10,000
Facilities for maintaining under controlled conditions animals used in studies on protein, mineral, and vitamin requirements of livestock, including paddocks, fences, and paved animal walkways	9,500
Facilities for manure disposal	6,600
Total	65,600

Note.--The additional facilities for which the increase is requested are for use in conducting research investigations falling under projects 1, 2, and 4 shown in the project statement. However, due to the character of the expenditure under the proposed increase, it is not feasible to allocate the increase in specific amounts to each of the three subject-matter projects.

CHANGE IN LANGUAGE

The estimates include a proposed change in the language of this item as follows (new language underscored, deleted matter enclosed with brackets):

> Animal husbandry: For investigations and experiments in animal husbandry and animal and poultry feeding and breeding, and for carrying out the purposes of Section 101(b) of the "Department of Agriculture Organic Act of 1944" (7 U.S.C. 429), authorizing cooperation with State authorities in the administration of regulations for the improvement of poultry, poultry products, and hatcheries, [$840,000] $994,000.

The sole purpose of the proposed change in language is to indicate the basic legislative authority for the cooperation with State authorities which is included in the language to describe adequately the work for which the appropriation is made.

(Continued on next page)

WORK UNDER THIS APPROPRIATION

Objective: Through research, (a) to develop means of improving the productivity, both in quantity and quality, of our domestic farm animals, including poultry; (b) in cooperation with State authorities, to administer regulations for the improvement of poultry, poultry products, and hatcheries; and (c) to administer the provisions of paragraph 1606 of the Tariff Act of 1930 providing for the certification of purebred animals imported by citizens of the United States for breeding purposes.

The Problem and its Significance: Livestock and poultry products vary greatly in quantity and quality per animal unit. Many losses occur which could be avoided by improved breeding, feeding, and management practices. Although the average productivity of the Nation's herds and flocks has increased many fold in the past half century, strains of animals and methods of feeding which outdo the present average in some cases by one and two hundred percent have been developed. The development of these strains of livestock and of these new principles of feeding repays many times over the cost of the research, but such research cannot be done by individual farmers and poultrymen as it is too time-consuming, too costly, and requires far too much pooling of trained talent.

General Plan: Investigations include (a) testing the merits of different systems of breeding; (b) developing strains possessing inherent characters for high level of performance; (c) studying the various management factors that tend to keep livestock healthy and reduce losses; (d) determining the fundamental nutritive requirements of livestock; (e) determining the best methods of using feeds to obtain maximum results in growth and reproduction; and (f) studying the effects of the foregoing and of processing upon the quality of meat, eggs, animal fibers, and other livestock products.

Receipts: During the fiscal year 1945, approximately $95,000 from the sale of livestock and livestock products which had served their purpose for investigational work was deposited to the miscellaneous receipts fund of the Treasury.

Examples of Progress and Current Program: The true worth of research is never more critically evaluated than under the stress and strain of a national emergency. In the acid test of the wartime period, when maximum production of livestock and livestock products under unusual and difficult conditions was imperative, the newer knowledge on the improved breeding, feeding, and management of livestock and poultry developed from the animal husbandry research program has been an important contributing factor to the successful development of the largest livestock and meat industry the Nation has ever seen. Not only were the answers to problems of particular wartime significance worked out, but information has been accumulated which will be useful in taking care of our future needs. A few examples of recent accomplishments and activities in various lines of livestock research will serve to illustrate the usefulness of each of these research categories:

Swine husbandry investigations: Experiments designed to develop improved strains of swine from crosses of the various breeds, followed by inbreeding and rigid selection, have resulted in the establishment of a number of inbred strains which are proving superior to parent stock in important production characteristics, notably in high reproduction and growth efficiency and carcass quality over that of the parent domestic breeds used in the crosses. The crosses have involved the following breeds:

Landrace and Chester White
Landrace and Duroc
Landrace, Duroc, and Hampshire
Landrace, Duroc, Hampshire, and Yorkshire
Landrace and Large Black
Landrace and Poland China
Yorkshire and Duroc

The system of inbreeding now being practiced permits more accurate selections for high-quality performance than would be possible under random breeding. While there is a slight decrease in fertility, vitality, and rate of growth as inbreeding advances, present indications are that any retrogression brought to light by inbreeding can be completely or almost completely offset by selection. General body conformation has been improved in practically all of the inbred lines. During the past year, a total of 15 boars of the inbred lines were placed in the hands of swine producers, through cooperation with State agricultural experiment stations, to obtain information on the relative merit of the progeny of these boars in the production of high-quality market hogs under actual field conditions. Reports on the performance of these boars are incomplete at this time, but those which have been received express satisfaction on the performance of the boars as sires of high-quality market hogs.

Studies have shown that when the supply of animal protein feeds are limited all-plant source rations, such as soybeanmeal, middlings, linseed meal, alfalfa meal, etc., can be prepared and fed with reasonably satisfactory results to sows during the gestation and suckling periods and to growing and fattening pigs. The pig crop was just as large in numbers and weights at weaning on the all-plant ration as on the one containing a high animal protein diet. However, diets containing animal protein feeds were more satisfactory for growing pigs, producing somewhat larger and more rapid gains.

Experiments to determine the comparative value of various feeds to protect pigs against a particular type of lameness or locomotor incoordination, resulting primarily from a lack of pantothenic acid, have shown that yeast and distillers' solubles are valuable for this purpose. Rations containing peanut meal and a commercial liver meal were not as effective in preventing the lameness.

A deficiency of vitamin A in the diet may lead to a watery condition observed in beef-cattle carcasses and referred to an anasarca. An experiment was conducted in which vitamin A deficient diets were fed at varying degrees

of the deficiency to determine whether a degenerative condition in the lean tissue observed at times in swine carcasses was due to lack of vitamin A After 6 months of feeding on the deficient diet, a nervous disorder developed in several pigs which was characterized by inability of the pig to stand erect or to walk normally. Blindness also developed in these same pigs. However, at slaughter, the carcasses appeared to be apparently normal.

Cull potatoes and surplus potatoes, in times of overproduction, are sometimes fed to hogs. Potatoes are not a good hog feed in the raw state, but must be cooked for best results. A trial test was conducted to determine the value of potato silage in the swine ration. The potatoes were steamed and placed in a small trench silo for a 6-week period. The potato silage was then fed with corn and a protein mineral supplement to a group of pigs. The pigs consumed the ration with relish, making rapid gains and efficient utilization of feed during the short trial feeding period.

Studies were initiated on different methods of curing as related to certain nutritive properties of smoked hams. Although incomplete, the results indicate that the protein of hams cured by the regular brine-immersion method is definitely of lower growth-promoting value than the protein of hams cured by the dry method or by the method involving artery pumping followed by immersion. The low value of the protein in the hams cured by the slow brine-immersion method appeared to be due, at least in part, to a deficiency of cystine. The thiamine content of the hams decreased during curing in all three instances, the losses ranging from 44 percent for the slow brine method to only 24 percent for the dry method.

Sheep, goat, and animal fiber investigations: Benefits are coming from this research program that are proving definitely useful in the Nation's production of meat, milk, wool, and other animal fibers, and fur. Encouragin progress is being made in the improvement of superior strains of sheep for the production of maximum quantities of lamb meat and wool of high quality. Specific methods of evaluating mutton characteristics and for promptly determining fineness, uniformity, freedom from kemp and medullated wool fibers (brittle fibers that do not take dye satisfactorily), length of staple, and clean wool content of individual fleeces of wool have been developed and used in breeding operations with the Bureau's experimental sheep at Dubois, Idaho; Beltsville, Maryland; and Middlebury, Vermont, and in cooperation with the State agricultural experiment stations of Arizona, Colorado, Montana, Texas, Utah, Washington, and Florida. The data resulting from these new and rapid research methods are being used promptly by the Bureau in the sheep-breeding research program. Many of the procedures developed have direct practical application in commercial sheep production and can be expected to yield equally beneficial results.

An effort is being made to develop simple and practical methods for breeding sheep out of their regular fall and winter mating seasons so as to control lamb production. This year, in order to get a basic understanding of the hormones that produce estrus, experiments were conducted at Beltsville, Maryland, to determine the most efficient dosages and combinations of hormones necessary to produce estrus. The relative effects of estrogenetic

hormones are being determined by test on 20 spayed ewes. Duration of estrus is being observed at different dosage levels as well as the intensity of estrus in different individual ewes. Preliminary results indicate that the minimum dosage of estradiol benzoate necessary to produce estrus in ewes is about 0.05 milligram. Estrus produced with this hormone is more prolonged than with comparable doses of the other hormones.

Similar hormone studies are in progress at Beltsville with milk goats in an effort to spread the production of milk by goats throughout the year. Seventeen spayed does were injected with stilbestrol, progesterone, or estradiol benzoate at varying dosage levels. Preliminary results indicate that for female goats the minimum dosage of the estradiol benzoate necessary to produce estrus was about 0.1 milligram. Experiments are now in progress to determine whether progesterone, injected after priming the animal with estradiol benzoate, will give a more normal exhibition of estrus. Information concerning the actions of these various hormone preparations is basic to an understanding of their action when applied to normal breeding animals.

Breeding investigations with Columbia and Targhee sheep at Dubois, Idaho, include efforts to eliminate horns which are often a troublesome management problem. Studies with 2,484 Columbia weanling lambs showed that 4 percent of the ram lambs had horns, 35 percent had scurs, and 61 percent were polled. In studies of 1,300 Targhee weanling lambs about 8 percent of the ram lambs had horns, 62 percent had scurs, and 30 percent were polled. About 7 percent of the Targhee ewe lambs had horns and 93 percent were polled. In both breeds some polled rams produced horned offspring and some rams with scurs produced no horned offspring. Rams with scurs produced more offspring with scurs and horns or horn knobs than did polled rams. Studies are being continued to determine the significance of scurs as related to the inheritance of polledness in Columbia and Targhee sheep.

Following up laboratory studies on rats with feedlot tests on fattening lambs, the relative values of different defluorinated phosphates in comparison with bonemeal as a phosphorus supplement have been determined. Manufacture of defluorinated phosphates on a large scale has been undertaken only within the past two years and this feeding research has been very helpful in standardizing the manufacture of high-grade products to supplement the inadequate supplies of bonemeal. It was found in the rat tests that temperature of defluorination was very important in determining the availability of the product to the animal. In the lamb-feeding tests, the three defluorinated phosphates which were tested were found to approach rather closely to bonemeal in availability. One of the products in particular shows great improvement over earlier samples.

At Dubois, Idaho, the Bureau, in cooperation with the Forest Service, has found that it is important to detect range deterioration before it becomes far advanced. Corrections in grazing management can then be made to halt the downward trend. The studies already are showing usable early signs of range depletion which it is believed may be adopted to improve range management practices. Furthermore, these studies show that sheep condition may not reflect range condition since deterioration of forage cover and soil may be well advanced before ewe and lamb weights decline. Range

reseeding, in conjunction with sagebrush eradication, offers a means of increasing forage two to ten-fold on spring-fall ranges. As with stands of native forage species, correct grazing management of reseeded stands is imperative. Studies at Dubois are providing much needed information on intensity of use and methods of grazing reseeded stands with sheep, as well as information on where, when, and how to reseed range lands intended for grazing sheep. Results of these cooperative grazing studies at Dubois have provided the basis for a prospective Farmers' Bulletin entitled "Grazing Spring-Fall Sheep Ranges in Southern Idaho," now in process of compilation. This bulletin offers simple and practical guides to improve yields of forage, lamb, and wool under range conditions. Studies of reseeding have contributed information included in two general guides on range reseeding for southern Idaho published by the Forest Service under the titles "How to Reseed Southern Idaho Range Lands" and "Regrassing Southern Idaho Range Lands."

The occurrence of hermaphrodites in goat herds is a troublesome problem. The Bureau's research on this problem at Beltsville has proved that hermaphroditism is transmitted as a recessive character associated with a polled condition (freedom from horns). Data accumulated over a period of 20 years prove that hermaphroditism can be controlled by using at least one horned parent in every mating. Applied genetic studies are in progress for determining the most efficient and practical methods of using this system of controlling the tendency for the occurrence of hermaphrodites in milk goats

Previous studies have shown that successful storage of cured lamb meat is more difficult to accomplish than the processing of a product that is pleasing in its freshly cured, smoked condition. Therefore, in the past year, studies were conducted to obtain further information on suitable methods for storing lamb. Legs fully exposed to air at 65° to 70° F., as well as those stored at 0° F., were free of mold after storage for 20 weeks. With partial exclusion of air there was only slight, unimportant mold growth on the meat, but with more complete exclusion the mold covering was present in a thick layer on practically the entire surface. The next task is to determine the relation of this information to factors of quality and to the use of propionic acid, resin-guaiac-treated lard, and other substances as inhibitors of mold growth.

Horse and mule husbandry investigations: A mobile energy-metabolism apparatus has been developed, in a cooperative project at the Missouri Agricultural Experiment Station. This apparatus will make it possible to conduct useful field tests of the energy expended by work stock in various types of farm work and in measuring the merit of individual animals. In the measuring of individual animals, the oxygen-pulse ratio, developed in the work of this same project, will serve as a good physiological index of their working capacity.

Breeding work in cooperative projects at the Tennessee and Mississippi Agricultural Experiment Stations continued. These projects are designed to improve jackstock and to determine the type of mare best suited for mule production. At the Tennessee Station most of the mules produced to date are from Tennessee Walking Horse mares, but some Percheron mares have been

purchased in order to obtain comparisons of the mules produced by the two types of mares. It has been observed that the mules from Walking mares are rather difficult to break, are good walkers, and are well suited to light work. However, they are smaller than the type that is in best demand among farmers. The possibility of testing jacks, rather than awaiting tests on mule progeny, is being considered as one means of speeding up the breeding program. At the Mississippi Station draft and saddle-type mares have been used. Great variability was observed in the mules produced from both types of mares. On the average, mules from draft mares were about 5 cm. taller at the withers, 3 cm. larger in depth and width of chest, and 5 cm. larger in heart girth than the mules from saddle mares. Mules from both types of mares were about equal in length of legs. In weight, the mules from draft mares averaged about 200 pounds more at maturity.

Beef and dual-purpose cattle husbandry investigations: The popular beef breeds have reached a very high standard so far as type and conformation are concerned, but little is known as to the ability of certain blood lines or families to transmit those characteristics responsible for the qualities most desired in beef cattle, such as rapid and efficient gains. The progeny testing programs in connection with record-of-performance studies for the past 10 years indicate that there are measurable differences in the breeding ability of cattle to transmit the most desired qualities. Sires which have been proved for efficient production of high-quality products have transmitted these characteristics to their sons and grandsons. For example, a three-generation group of Shorthorn sires at Beltsville, Maryland, has been proved through a system of progeny testing. A fourth generation sire of this group have been used in one of the test herds in 1945. In each generation to date there has been a gradual increase in the production efficiency of the progeny of each sire.

Additional progeny tests with Hereford cattle at the U. S. Range Livestock Experiment Station at Miles City, Montana, also indicate measurable differences in the performance between bulls of unrelated lines, based on rate of gain, efficiency, and carcass quality. The time required to reach a slaughter weight of 900 pounds has been shortened materially in some sire groups. At the same time the efficiency of feed utilization and carcass quality have been improved. Cross-breeding experiments have shown the possibilities of increasing the beef supply, as measured by heavier calves at weaning and when slaughtered at 15 months of age, when compared to straight-bred cattle, and also by heavier heifers at 18 months of age. Cross-bred steers were heavier, brought higher sales prices, and made greater net returns than did straight-bred cattle handled under the same conditions. The straight-bred cattle were slightly more efficient in their use of feed, but from a strictly beef-production standpoint, all points considered, the cross breds were the most satisfactory.

The feeding of phosphorus supplement to range breeding cattle grazing on vegetation that is deficient in this mineral increases the returns to the beef producer through higher percentage calf crops and heavier calves at weaning time. The first three years of experiments (1938-41) conducted in South Texas cooperatively between the King Ranch, the Texas Agricultural

Experiment Station, and the Bureau show that the feeding of phosphorus supplements by hand dosing in the form of bonemeal and disodium phosphate prevents phosphorus deficiency diseases and corrects those not too far advanced. The feeding of 6.5 grams of phosphorus per head daily has been sufficient. Studies over a 7-year period show rather definitely that the feeding of twice this amount to lactating cows produces no additional benefits. In the first series of tests the percentage of calf crop was increased about 35 percent and the weaning weight of calves about 70 pounds by supplying phosphorus in addition to that present in the vegetation. After deducting the cost of the supplement fed the cows for a year, the calves from the cows receiving the additional phosphorus showed an increased valuation of $5.75 more per head than those from the control cows fed no phosphorus supplement.

In later experiments started in 1941 it has been shown that such phosphorus supplements as bonemeal and a mixture of disodium phosphate (90 percent by weight) and cottonseed meal (10 percent) can be fed satisfactorily by the use of self feeders, that phosphorus can also be fed satisfactorily by the use of disodium phosphate dissolved in the drinking water, and that range cattle can be supplied sufficient phosphorus by grazing vegetation on land fertilized with a triple superphosphate. The results of these experiments to date indicate clearly that beef production can be increased materially on phosphorus-deficient ranges by supplying phosphorus in forms that can be administered by practical methods such as by the use of self feeders, in the water supply, or by pasture fertilization. It is estimated that if one-half of the breeding cows in phosphorus-deficient areas were fed phosphorus supplements in sufficient quantity to meet their requirements the tonnage of beef could be increased by more than 20,000,000 pounds a year, based on the steer calves if marketed at from 8 to 10 months of age.

Sweetpotato meal, the product resulting from the dehydration of sweetpotatoes, is proving to be a rather satisfactory feed for fattening cattle in the Southeast where yields of 200 bushels of potatoes per acre can easily be produced and where other carbohydrate feeds suitable for beef production are comparatively limited. Tests in cooperation with the Georgia Coastal Plain Experiment Station at Tifton, Georgia, over a three-year period show that sweetpotato meal compares very favorably with corn when six parts by weight of the sweetpotato meal are combined with one part of cottonseed meal and fed in conjunction with peanut hay. In two years out of three, the sweetpotato meal proved slighly superior to cracked shelled corn as measured by efficiency of gains. The mixture of equal parts sweetpotato meal and corn appeared to be equally as efficient and palatable as cracked shelled corn. The results of these tests suggest the justification of fattening greater numbers of cattle on concentrates in the region.

The production of grain sorghums in the southern Great Plains has increased rapidly during the last 20 years, and along with this has been a trend toward the fattening of greater numbers of cattle on these feeds in the area. Feeding problems have presented themselves, particularly in the dry-lot fattening of steers on rations supplying the carbohydrate concentrates solely from grain sorghums. The most serious problem is the formation of calculi in the urinary tract. Feeding tests with the grain sorghums were

therefore modified so as to study the calculi problem. First results suggested that the formation of urinary calculi was associated with an improper ratio of calcium. The formation of calculi seemingly was accentuated by feeding high calcium and magnesium ratios, and when the phosphorus ratio was high in proportion to calcium and magnesium significantly less calculi were formed. In later experiments the feeding of ground shelled corn in place of ground milo resulted in a significant lowering of the amounts of calculi formed in the bladders. There are also more calculi formed when milo heads are fed than when the threshed grain is used, indicating that the pumace or fibrous stemmy material in the heads contains material favorable to calculi formation. The southwestern grain sorghum area is capable of producing large quantities of finished beef comparing favorably with that produced from corn if the formation of calculi can be controlled.

In areas where cottonseed meal and hulls are depended upon almost solely for the fattening of cattle for beef, losses of considerable magnitude, as represented by low gains and in some instances deaths, have resulted from vitamin-A deficiencies. Recent investigations have proved that vitamin-A deficiencies in cattle-fattening rations can be controlled when from 2000 to 2500 milligrams of carotene are supplied for each 100 pounds live weight of cattle. Dehydrated alfalfa leaf meal has been proved to be a more effective source of carotene than silages made from sorgos or sorghums, when these feeds were fed so as to supply the same quantity of carotene. As little as one-half pound of choice-quality dehydrated alfalfa leaf meal, in otherwise vitamin-A-deficient rations for yearling cattle, may meet the carotene requirements.

Grazing intensity studies at the U. S. Range Livestock Experiment Station, in cooperation with the Forest Service and the Montana Agricultural Experiment Station, show that over the 11-year period ending in October 1944 weaning weights have averaged 275.5, 321.8, and 327.2 pounds per cow unit and the calf crops have averaged 78.2 85.0, and 85.5 percent, respectively, for the cows on the heavily, moderately, and lightly grazed areas. Calves from heavily grazed pastures have thus averaged 46 and 52 pounds lighter per cow unit than the other two groups. Also the cows on the heavily stocked pastures have had the additional disadvantage of requiring substantially more supplemental feed on the average. Thus, while calf weights in some unusually favorable years are equal or slightly higher on heavily stocked ranges, such use is on the average a severe disadvantage as compared to more conservative stocking.

In the coastal region of the Southeast there are vast areas of forest land which are not being fully utilized. Studies over a period of 3 years indicate that severe winter weight losses in cattle of the region can be avoided by feeding as little as 2 pounds of protein concentrate per head daily, as a supplement to the range vegetation. The cows wintered on 2 pounds of the supplement were in nearly as good condition at the close of the summer grazing season as those in the other groups, fed 4 and 6 pounds, respectively, because of greater subsequent summer gains. Wintering beef breeding cows in the forests on native forage and a moderate amount of protein concentrates appears to be practical and economical for this region. There were indications that the feeding of cottonseed meal stimulated the cow's appetite,

resulting in a greater use of the native range. Studies started in the summer of 1943 on the Hofmann Forest in North Carolina to determine the effect of cattle grazing on tree production following logging and the effect of logging and degree of use on grazing showed that when pastures are stocked at the rate of 6 and 9 head of cows with their calves, respectively, to 48 acres, there is apparently no significant difference in rates of gain between the cattle on the unlogged and logged areas. Grazing observations revealed no evidence of pines being browsed. The mortality of seedlings was greater on grazed areas than on ungrazed, but conditions were more favorable for germination and establishment of new seedlings on the grazed areas. Studies will have to be continued over a period of several years in order to determine the full effect of cattle grazing on pine seedling population. There are indications that these forest areas in the Southeastern Coastal Plains will furnish considerable forage for beef cattle, particularly during the early part of the grazing season, without seriously affecting natural reforestation.

In comparisons of four strains of dual-purpose type Shorthorn cattle, each represented by 17 to 41 steer progeny of three to five sires, no significant differences in carcass grade, yields of the more preferred cuts, or tenderness were found. However, a number of significant differences between the strains were found with respect to the proportions of separable fat and edible meat of the dressed carcasses and also in relation to ether extract (fat) content of the edible meat and of the lean tissue. These and other similar results furnished further evidence of the importance of breeding in influencing factors of meat quality. As a further step in this line of research, study of the usefulness of percentage values for certain combinations of the more preferred, higher-priced cuts as indexes of carcass merit in cattle-breeding studies was initiated. Among 165 beef and dual-purpose type Shorthorn steers weighing 875 to 924 at slaughter it was found, for example, that the sum of the percentages of the rib, loin, loin end, and shortloin cuts varied from 22.7 to 27.8 percent. This variation in percentage represented a maximum difference of 46 pounds, obviously of distinct importance. Moreover, the results indicated significant differences with respect to yield of cuts between the progeny of certain sires.

In recognition of the increasing interest in the preservation of meat by freezing and the many problems related thereto, studies were continued on the freezing and freezer storage of beef. Results indicated that thin (commercial grade) beef was tenderized more by freezing than was fat (Choice grade) beef. The respective tenderizing effects were about 10 percent and 6 percent. With paired muscles from the right and left sides of the same carcasses used, one sample of each pair was tested for tenderness after 14 days' aging at 35° F., whereas the other sample was aged under the same conditions, frozen at 0°, thawed at 45°, and then tested.

Poultry husbandry investigations: Poultry breeders have used proved methods of individual and family selection to increase the egg production of their flocks, and the rate of growth and feathering of their poultry during the growing period. Many breeders have reached the apparent limit

of improvment with these methods. New methods of breeding for increased egg production, based on the selection of inbred families of high fecundity followed by the cross-mating of unrelated inbred families, are producing layers of still higher egg production capacity under experimental conditions. Further research to develop superior inbred families and to test the progeny of these families is necessary.

Efficient poultry meat production depends on rapid growth and feathering, efficient feed utilization, and excellence of carcass quality. The Columbia strain developed at the Agricultural Research Center (Beltsville) and the Brooksville Station combines these qualities to a considerable extent. It has the added advantage of yielding broilers with light-colored pin feathers in purebred and cross bred matings. Further research is required on fecundity and carcass quality of this strain before it is ready for distribution to farmers and poultrymen.

The Golden Leghorn strain at the Agricultural Research Center combines white egg shell color and high rate of egg production with genetic factors which make it possible to distinguish the sexes at hatching time in cross-bred matings with the Black Minorca which is also a white egg variety. Males from this cross are barredin pattern. Poultrymen now lack a white egg cross which will produce the desired barred offspring and use of this cross may lead to the greater usefulness for meat production of male chicks from white egg matings. Millions of the day-old males from white egg matings are destroyed or sold at a very low price during normal years. Further research is necessary to improve shell color, egg weight, and plumage color in the Golden Leghorn.

The Beltsville Small White turkey produced at the Agricultural Research Center has been widely distributed in the United States. During the current year a small lot of hatching eggs sent by air to Great Britain was successfully hatched. The unusual fecundity of this strain together with its size, fixed for suitability for family use, make it of increasing popularity. Research is under way to add the Broad Breasted factor to further improve carcass quality.

Breeding research with chickens, based on individual and family selection for the improvement of egg quality, has resulted in strains with superior shell quality, relative freedom from bloodspots, superior physical condition of egg contents at time of laying, and superior ability to withstand hot weather after laying. Application of these research results by poultry breeders may result in eggs suffering much less frequent breakage than is presently true and in eggs which will retain table quality without refrigeration for a much longer period of time. Further research is needed to establish the manner of inheritance of the factors responsible for these qualities and to combine all of them in one strain of superior chickens.

Wider utilization of dried eggs will require methods for preventing their deterioration. Drying of egg yolk material has been found to denature a large part of the protein by breaking the natural emulsion of the fat-protein complex present. This is true if the egg material containing yolk is spray dried or dried under vacuum from the frozen state. This denaturization of the yolk material continues during the storage of the dried product.

The addition of 10 to 20 percent of disaccharides, sucrose, or lactose, to the whole egg mixture prior to drying protects the emulsion, so that it does not become so insoluble during storage. A similar breaking of the natural emulsion of the yolk is found on freezing yolk material to 0° F. This also may be protected by the use of sucrose or lactose,

Research on the effect of low atmospheric pressures on the hatchability of hens eggs has assisted in the initiation of air shipment of hatching eggs to all parts of the world. The effect of reduced atmospheric pressures on hatchability of eggs was investigated under conditions simulating those encountered in air transport, including equivalent standard altitudes much beyond the range of present practicability. The hatchability of control eggs and eggs subjected to reduced pressures corresponding to standard altitudes as high as 78,000 feet was about equal. It is concluded that reduced pressures incidental to air transport of fertile eggs are of no practical significance. Representatives of the Bureau have advised on conditions required for successful air transport which have contributed to successful shipments to Brazil, Peru, England, and the U.S.S.R.

During the past year, studies of poultry feeds containing large quantities of soybean oil meal, the most plentiful protein supplement, have revealed that this material can be used successfully as the sole protein supplement in laying mashes containing no animal proteins, and that the same is true of growing mashes which contain wheat as the principal grain. When the grains are used, small quantities of animal protein of high quality are needed for good growth. In diets for breeding stock soybeanmeal may be used with other protein supplements, but high levels of soybeanmeal have a depressing effect on hatchability and viability of chicks hatched. More study must be given to this effect, which is exerted even in the presence of seemingly adequate quantities of the known nutrients. Of various materials added to diets high in soybeanmeal, dried cow manure most effectively improves hatchability and viability

An investigation of the availability of the phosphorus of defluorinated superphosphate, which is being manufactured in large quantities to relieve the shortage of phosphorus in feeds, showed that there was great variability among different samples with respect to availability and solubility. These two properties were found to be closely related to each other so that solubility can serve as a quick test to indicate availability.

The National Poultry Improvement Plan has been in operation since 1936. During this period of time the average annual egg production per hen in the United States has increased by 18 eggs. The operation of the plan has been an important factor in the accomplishment of this increase by enabling poultrymen to obtain chicks of a higher productive capacity. The provisions of the plan when applied by hatcheries have proved to be effective in reducing chick losses. For example, chick mortality data gathered by the participating hatcheries in one cooperating State in 1943-44 showed an average loss of only 3.91 percent on 2,365,000 chicks started. The following table, showing participation for the fiscal years 1936, 1940 and 1945, illustrates the rapid growth of the work:

National Poultry Improvement Plan

Item	Extent of participation during years ended 6/30		
	1936 (Number)	1940 (Number)	1945 (Number)
States	34	44	45 1/
Hatcheries	1,017	2,192	3,181
Egg capacity of hatcheries	38,066,000	90,678,718	206,259,311
Hatching-egg-supply flocks	23,813	50,559	73,578
Birds in hatching-egg-supply flocks	3,522,409	10,714,238	18,592,302
Birds officially tested	4,322,800	11,105,307	21,098,026
U.S.R.O.P.,(U.S. Record of Performance)flocks	190	429	444
Birds trapnested under R.O.P. supervision	66,547	144,447	173,183
Females in U.S.R.O.P. matings	8,207	32,949	53,081

1/ California and Nevada have adopted the plan since July 1, 1945.

Thirty-two of the States are now cooperating in the turkey phase of the National Poultry Improvement Plan which was placed into operation September 25, 1943, and has been designated as the National Turkey Improvement Plan.

The foundation poultry breeding stock used by hatcheries in improving their flocks is being produced by more than 500 trap-nest pedigree breeders, of which 320 are participating in the U.S. Record of Performance breeding stage of the National Poultry Improvement Plan. A large number of these breeders have obtained a reasonably high productive quality with their present breeding methods, but studies of the U.S.R.O.P. records show that breeders must trap-nest a much larger number of pedigreed birds selected on the basis of representative families in order to make progress above the present level. At least three-fourths of the males used in hatchery-supply flocks are selected merely on the basis of appearance. The males used for this purpose should be selected on the basis of family records or the progeny-test records of their parents insofar as possible.

To effectively control pullorum disease it is necessary not only to use good techniques in performing the test but to repeatedly test the breeding flocks and remove the reactors until few or no reactors are found. Progress has been made in this direction but a great deal remains to be done. For example, 1360 of the cooperating hatcheries in 1945 met only the requirements for the U.S. Pullorum Tested class which permitted up to 6 percent reactors

in the flocks on the last test. The reactor tolerance for this class, which will be "fewer than 5 percent" for 1945-46, should continually be reduced at least 1 percent each year because the mortality of chicks is reduced proportionately.

Certification of pedigrees of imported registered livestock: During the fiscal year 1945 a total of 21,978 purebred animals were certified, a decrease of 2,421 animals or 9 percent under the previous year. Certifications of animals by species were: 40 horses; 18,065 cattle; 2,985 sheep; 2 goats; 325 swine; and 561 dogs.

(Continued on next page)

(c) Diseases of Animals

Appropriation Act, 1946		$708,900
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+76,000
Total anticipated available, 1946		784,900
Budget estimate, 1947		895,000
Change for 1947:		
Overtime decrease	-$9,750	
Increase	+119,850	+110,100

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Investigations of brucellosis (contagious abortion) of livestock	$247,501	$265,755	$267,397	+$1,642 (1)
2. Investigations of infectious diseases of livestock and poultry caused by bacteria and fungi, other than brucellosis	92,159	129,601	130,399	+798 (1)
3. Investigations of infectious diseases of livestock and poultry caused by viruses	65,396	87,869	88,413	+544 (1)
4. Investigations of non-infectious diseases of livestock and poultry	42,768	47,372	47,682	+310 (1)
5. Investigations of protozoan parasites of livestock and poultry, including coccidiosis	67,300	71,065	71,517	+452 (1)
6. Investigations of worm parasites of livestock and poultry, etc.	69,173	76,977	77,455	+478 (1)
7. Investigations of miscellaneous parasites of livestock and poultry	36,173	43,120	43,405	+285 (1)
8. Investigations of treatments for parasites of livestock and poultry	46,008	53,391	53,732	+341 (1)
9. Investigations in Alaska of diseases and parasites affecting livestock and poultry	- - -	- - -	10,000	+10,000 (2)
10. Construction of poultry and zoological laboratories	- - -	- - -	105,000	+105,000 (3)

PROJECT STATEMENT (Continued)

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
11. Overtime pay	$67,723	$9,750	- - -	-$9,750
Covered into Treasury as miscellaneous receipts, Public Law 529	19	- - -	- - -	- - -
Unobligated balance	46,698	- - -	- - -	- - -
Total available	780,918	784,900	895,000	+110,100
Transferred to "Salaries and expenses, Office of Information, Department of Agriculture"	+200	- - -	- - -	
Anticipated supplemental	- - -	-76,000	- - -	
Total estimate or appropriation (1945 adjusted for comparability)	781,118	708,900	895,000	

INCREASES AND DECREASES

The net increase of $110,100 in this item for 1947 consists of the $9,750 decrease for overtime, and the following:

(1) Increases totaling $4,850 (as reflected in the first eight project items) for placing on a full-year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(2) An increase of $10,000 for inaugurating exploratory investigations in Alaska of diseases and parasites affecting livestock and poultry:

Objective: To determine by means of exploratory investigations, the possibility of expanding farm operations in Alaska, particularly with regard to diseases and parasites affecting livestock and poultry.

The Problem and Its Significance: Present demand is greatly in excess of the available locally produced farm products. Increased settlement in Alaska is expected, particularly by returning service men. Alaska will no doubt play an important role in future air commerce and travel. The development of mining, forestry, and industry, especially along new trade routes, will further increase the need and demand for agricultural products. Agricultural settlement accompanies such development and creates demand for information as to areas most favorable for farming, including the control of diseases and parasites of livestock and poultry which are limiting factors in production as they cause unthriftiness, digestive upsets, and death losses, especially in young animals. Diseases and parasites are responsible, moreover, for condemnations under meat inspection of carcasses or parts, the sum total of the losses so sustained

being very significant. Some diseases and parasites of food animals are transmissible to man, their occurrence in livestock constituting a human health hazard. Although the diseases and parasites of livestock and poultry in Alaska have not been systematically investigated and knowledge concerning them is very scant, there is reason to believe that many of them play an important role in the economy of livestock and poultry production in that Territory. The Alaska reindeer is known to harbor stomach and intestinal roundworms that are transmissible to sheep; tapeworms that are transmissible to cattle, sheep, and hogs; and bladderworms transmissible to dogs and, through these animals, also transmissible to man, cattle, sheep and hogs.

Plan of Work: Two experienced research men, one a veterinarian and the other a parasitologist would be detailed to Alaska to work in close cooperation with the Alaskan Experiment Station, other responsible territorial officials, and agencies of the Federal Government concerned with the related aspects of the problems studied. The initial procedure would be to work out, in collaboration with local officials, the best methods of approach to solve the more critical problems facing livestock and poultry production in the area and then to make investigations of the extent and prevalence of the various diseases of livestock and poultry; to make a systematic survey, through post-mortem examination and in other ways, of all classes of livestock and poultry in Alaska to determine the species of parasites harbored by them; to ascertain the prevalence of parasites at different seasons; to investigate the parasites of wild ruminants, dogs, and other wild carnivores in order to determine whether these animals harbor species that are transmissible to farm animals; to investigate the period of survival of parasites on pastures under climatic conditions prevailing in Alaska; to investigate small invertebrate animals as possible intermediate hosts of livestock and poultry parasites; to determine the feasibility of parasite control by medical treatment during the cold season; and to acquaint farmers in the Territory with practical methods of coping with livestock and poultry parasites.

(3) An increase of $105,000 for the construction of poultry and zoological laboratories, as follows:

(a) $30,000 for the erection at the Agricultural Research Center, Beltsville, Maryland, of a properly equipped building to investigate pneumoencephalitis (Newcastle disease) in poultry in the United States:

A disease of poultry that had existed in California for several years was identified in 1942 as a new disease and given the name pneumoencephalitis. It was later found that the virus of this disease was identical with that causing Newcastle disease. The latter disease as it appears in other countries causes a very high mortality. While mortality from the disease in California has been estimated at 5 to 10 percent, it has been extremely infectious and has caused heavy losses from decreased egg production. Recently the disease has been discovered in the State of New Jersey, and it is suspected in several other eastern States. The disease is a threat to the poultry industry of the country at large, and

investigational work looking to the development of methods for its control is urgently needed. Since the disease is of a highly contagious nature, it will be necessary that experimental work be undertaken under conditions whereby it cannot be disseminated to our poultry flocks. A special type of experimental building will be necessary to perform this work with safety. At such time as the building becomes available, it is proposed, within our regular framework of personnel and funds for conducting research on diseases of animals, to inaugurate laboratory investigations to study the causative agent, modes of transmission, diagnosis, and the development of preventive vaccination."

(b) $75,000 for enlarging the zoological laboratory building at the Agricultural Research Center, Beltsville, Maryland:

The present zoological laboratory was planned in 1934, and completed early in 1936, to accommodate only a portion (about 50 percent) of the technical staff located in Washington, D.C. engaged in laboratory research work on parasites of livestock and poultry. In 1942 all the work formerly done in Washington was moved to Beltsville. To accomodate the entire staff, three buildings, namely (a) a barn, (b) a building for small animals such as rats, rabbits, guinea pigs, and (c) a smaller animal shelter, were converted into laboratories and office rooms. These buildings are needed for the purpose for which they were designed. To release these three buildings, the present laboratory building must be enlarged by about 50 percent, at an estimated cost of $75,000. The laboratory work to be done in the enlarged building will include investigations on parasites of horses, cattle, sheep, goats, hogs, and poultry; investigations of parasites of food animals transmissible to man; and investigations of drugs to discover more effective treatments than are now available to parasitic diseases of livestock and poultry.

Note.-The additional building facilities for which the $105,000 increase is requested are for use in conducting research investigations falling under projects 3, 5, 6, 7, and 8 shown on the project statement. However, due to the character of the expenditure under the proposed increase, it is not feasible to allocate the increase in specific amounts to each of the five subject-matter projects.

CHANGE IN LANGUAGE

It is proposed that there be added to this item language covering construction work for which increased funds are proposed in the estimates. The item would then read as follows: (Added language underscored)

"Diseases of animals: For scientific investigations of diseases of animals, and necessary expenses for investigations of tuberculin, serums, antitoxins, and analogous products, [$708,900] $895,000, including not to exceed $30,000 for construction of a building to be used in conducting investigations of pneumoencephalitis in poultry and not to exceed $75,000 for enlarging the zoological laboratory building at the Agricultural Research Center".

Authority for this construction is contained in Section 703 of the Department of Agriculture Organic Act of 1944, approved September 21, 1944.

WORK UNDER THIS APPROPRIATION

Objective: (a) To obtain information leading to measures for the control of the infectious and non-infectious diseases of domestic animals, including poultry, which are of particular importance at the present time; and (b) to develop practical methods of coping with the numerous parasites that produce stunting, unthriftiness, and deaths in livestock and poultry.

The Problem and its Significance: The losses to the livestock industry from diseases and parasites total millions of dollars annually. Many animal diseases and parasites are also communicable to man and are a menace to public health. Since the organization of the Bureau of Animal Industry, research work on the cause, mode of transmission, and measures for the control of infectious and parasitic diseases, has been one of its major efforts.

To control diseases and parasites it is necessary to have certain fundamental information on the causative agents, how they are propagated, and how disease is produced and spread from one animal to another. When adequate information on these points is available, efforts can then be directed to the development of measures whereby losses from a particular disease can be reduced, or the disease even eradicated. These efforts may take in studies on sanitary measures, vaccination procedures, and the use of therapeutic agents. As a result of such research, great strides have been made in the control of many animal diseases and parasites in the United States through concerted efforts of Federal and State agencies. However, many problems are continually arising in disease control programs which need further investigation. Advances are constantly being made in methods of research, and new drugs are being developed for the treatment of diseases. Continued research on animal disease problems is essential to improvement of existing methods for their control and eradication. Moreover, new diseases are reported from time to time, and investigations are necessary to identify them and to develop methods for their control. Heavy losses are produced through poisoning of stock by plants, and considerable losses are caused also by non-infectious diseases. Full information is not at hand on many of the diseases affecting the nation's livestock and poultry. Work under this appropriation is directed toward obtaining information through research activities, both in the laboratory and in the field, on methods of controlling and eradicating diseases and parasites, and thereby safeguarding human as well as animal health.

General Plan: Investigations are made into methods of diagnosis, cause, mode of transmission, and methods of prevention, treatment, and control of the more important infectious and non-infectious diseases of livestock including poultry. These investigations embrace field and laboratory activities. Studies of the diseases as they exist in the field are made, and the bacteriological, serological, pathological, immunological, and animal inoculation studies are conducted in the laboratory.

To develop a practical and scientific basis for eradicating or controlling parasites, (1) studies are conducted on the distribution of these pests in the major agricultural regions of the United States, taking into consideration climate, soil types, pastures, and topography; (2) methods are developed for accurate diagnoses; (3) the infective states are investigated with a view to developing methods for their destruction; (4) the mode of transmission is determined by experiments in the laboratory and observations in the field; (5) the injuries produced and symptoms exhibited by experimentally-infected animals are noted in order to develop sound methods for field diagnosis; (6) the immunological responses, if any, are investigated as aids in control; (7) weak links at which the vicious cycles of parasites may be broken are explored; (8) intermediate hosts are investigated and methods are devised for their eradication and control; (9) field tests to develop promising control measures are conducted on a small scale under conditions that enable the investigators to determine the factors that might be involved; and, finally (10) the most promising control measures are tested in the field in cooperation with farmers and stockmen, and control measures are adapted to meet varying conditions existing in different parts of the country.

To meet the ever-pressing need for affording infected animals prompt relief from the drain of parasitic infestations and saving the lives of young animals that have but little resistance to cope with mass attacks by parasites, experiments are conducted with drugs and chemicals to determine effective and inexpensive methods of destroying external parasites on, and removing internal parasites from, livestock and poultry. Investigations are conducted also to develop practical methods of destroying the infective stages of parasites in the manure, which is the most fertile source of parasitic infestation on the farm and range.

Progress and Current Program:

Investigations of brucellosis (contagious abortion) of livestock: Considerable interest has developed during the past few years in the administration of Brucella abortus, strain 19 vaccine, by intracutaneous methods. Unfortunately, however, no data from controlled experimental studies are available from which its real value or limitations can be judged. The relatively few observations made in connection with field trials have indicated that small quantities of vaccine injected between layers of the skin usually stimulated the production of blood agglutinins and opsonins to a degree comparable with those associated with subcutaneous injections of the usual 5 cubic centimeter amounts. Neither of these blood elements, however, are acceptable at present for estimating the degree of resistance induced. In order to assess more accurately the real value of intracutaneous vaccination, carefully controlled experiments are now being conducted on a group of 31 heifers selected for this purpose. At the present time observations in these animals have covered a period of six months following vaccination. The results of frequent blood examinations have shown the opsonin and agglutinin levels to be of the same relative order,

regardless of the vaccination procedures employed. The entire group, including adequate controls, will be exposed later to virulent infection and the final results should permit a critical comparison of the two methods based on the actual resistance established. Until such time as information of this nature is available, unqualified acceptance of intracutaneous vaccination as a substitute for the proved subcutaneous method of administering strain 19 does not appear to be justified.

Further basic studies dealing with swine brucellosis have shown that persistent discharge of the causative organism by infected adult swine is far more common than heretofore known. Although various channels of dissemination, including uterine discharges, udder secretions, semen, and urine have been recognized in the past, spread of infection from these sources has generally been considered to be of relatively short duration. This opinion has been disproved, however, by recent investigations in which the vaginal discharges and urine have been found to be infective for periods of 6 months and longer after primary infection has occurred.

Out of a group of 38 artificially exposed sows held under close observation, Brucella suis has been recovered from catheterized urine samples of 10, or 26.3 percent, at intervals ranging from 3 to 6 months following exposure. Over a similar period 9, or 23.6 percent, of the animals in this same group were found to have a persisting vaginal infection. In this connection, it was also observed that continued urinary bladder infection can be present in sows without concurrent vaginal involvement. In line with the notable absence of kidney and genital tract infection in a significant number of these cases when they are examined on autopsy, it would appear that chronic bladder infection may become established by extension from the vagina and persist after its disappearance from the genital tract.

The importance of these findings lies in the bearing they have on the development of suitable control recommendations. Therefore, in view of the potential danger of re-exposure associated with known Brucella infected sows for long periods after the disease originally develops, it does not seem advisable to retain such animals in herds where eventual eradication of the disease is desired. Under average field conditions, continued discharge elimination of infection from the uro-genital tracts of diseased sows in this manner may provide sufficient exposure through contamination of feed and water to explain the failure to limit spread of the disease where prompt elimination of known infected animals is not practiced.

The importance of the infected boar in perpetuating and spreading brucellosis to susceptible swine continues to be one of the more significant differences found in the characteristics of this disease in swine as compared with cattle. Increasing evidence supplied by experimental studies underlines the need for exercising every precaution possible in the selection of boars for breeding purposes. On the basis of experimental and field results now available, it is apparent that intravaginal exposures are probably responsible for most of the early Brucella abortions that occur in swine.

Investigations of infectious diseases of livestock and poultry caused by bacteria and fungi, other than brucellosis: The campaign for the control of bovine tuberculosis is based on the detection of diseased animals through the use of the tuberculin test (the intradermic injection of a specific agent, tuberculin, made from the tubercle baccillus). The tubercle bacillus belongs to a group of organisms known as acid fasts (acid resisting), some of which are capable of sensitizing an animal so that it will react to the tuberculin test but not be affected with tuberculosis. Such type of reactors, which shown no visible evidence of tuberculosis on post mortem, are known as no-visible-lesion reactors, or NVL cases.

In studies of the effect of age on the potency of tuberculin, comparative tests were made in cooperation with the Regional Animal Disease Research Laboratory at Auburn, Alabama of 51 intradermic tuberculins prepared during the last 12 years and stored, since preparation, at room temperature. The tests were made on cattle by the multiple test method developed at the Auburn laboratory. The results indicated that there was a gradual loss of potency during the years, but the loss was slight since every tuberculin tested still produced, even when diluted ten times, a reaction in every sensitized animal tested, and many gave recognizable reactions when diluted 100 times. In similar tests of 5 other tuberculins, which had been held at 37.5° C. for varying lengths of time and then stored at room temperatures, no loss of potency could be detected.

About 400 different products have been prepared and tested in connection with recent attempts to increase the potency and specificities of allergens, chiefly johnin and mammalian tuberculin. It was found possible by appropriate methods to increase the potency of johnin as well as of tuberculin.

The investigation of penicillin as a treatment for mastitis has been continued. In attempting to evaluate the usefulness of a new drug in the treatment of mastitis, one of the first steps is to determine by laboratory test if the drug will inhibit the growth of or destroy the responsible bacteria. During the past year 150 cultures of bacteria, isolated from the milk of cows having varying degrees of mastitis, have been tested for their sensitivity to the action of penicillin. The results of these tests indicate that the types of organisms most commonly associated with mastitis are, in general sensitive to penicillin. However, in the clinical trials of penicillin in bovine mastitis, this drug did not cure all quarters of the udders proved by laboratory tests to be affected with penicillin-sensitive organisms.

The control of swine erysipelas by use of simultaneous vaccination with live culture vaccine and hyperimmune serum was continued on an experimental basis in 14 cooperating States. During the year 22,636 herds containing 1,438,113 hogs were vaccinated, and the results obtained were very satisfactory.

An investigation was made of an outbreak of Erysipelothrix rhusiopathiae infection in chickens. The disease in chickens, which is reported to have made a sporadic appearance in European flocks since 1910, has been observed only once in the United States prior to this investigation.

Losses from fowl typhoid in the broiler-raising areas continued to be serious in both layers and broilers. In some cases chicks were affected at 3 to 4 weeks of age. Evidence was accumulated to show transmission of fowl typhoid through the egg and by pen contact.

Investigations of diseases of livestock and poultry caused by viruses: As in the past, special emphasis was placed on the importance of investigating outbreaks of vesicular diseases in livestock so that an accurate diagnosis may be made promptly, and every step taken to preclude failure to recognize the presence of the most dreaded of these plagues--foot-and-mouth disease. During the year outbreaks of a contagious vesicular disease of livestock in Colorado and California were investigated and in each instance the virus of vesicular stomatitis was found to be the causative agent. All strains isolated were found to be of the New Jersey type. In experimental studies of vesicular stomatitis infection, it was found that although a substantial immunity could be produced in animals by inoculation of living virus, in some cases the immunity was of short duration. This necessitates testing the immunity of animals before using them to determine the type of an unknown virus. The results of tests indicate that the heating of antisera at 58° to 59° for 30 minutes, as now required of licensed biological firms by the Department, will render these products free from vesicular stomatitis virus. It has also been shown that the virus will not survive the incubation in the presence of crystal violet which is now prescribed for preparing crystal violet hog cholera vaccine. Carbolic acid has been found to have only a slow killing action on vesicular stomatitis virus present in hog cholera blood held in the refrigerator. A sound motion picture film illustrating the clinical symptoms of the three vesicular diseases; foot-and-mouth disease, vesicular stomatitis, and vesicular exanthema in cattle, hogs, horses, and guinea pigs, and laboratory methods of distinguishing these diseases was prepared. The film has been shown to large numbers of veterinarians and livestock sanitary officials throughout the country.

The calendar year 1944 marked the tenth consecutive year in which statistical data on outbreaks of infectious equine encephalomyelitis have been gathered. Reports of 19,590 cases occurring in 33 states with 4,779 deaths were received. More than 82 percent of the cases occurred during the months of August, September, and October, and nearly 90 percent of all cases were reported from the West North Central and West South Central States. The rate of incidence of the disease in a large group of vaccinated animals in counties where the disease appeared was only 0.2 per thousand as against 2.9 per thousand in unvaccinated animals. The importance of determining the immunologic type of virus so that the proper vaccine may be

administered was again demonstrated when eastern type virus was identified in Missouri whose geographic position strongly suggested that western virus was operating. Eastern type virus, as was to be expected, was recovered from Louisiana. During the fall of 1944 a serious outbreak of the disease occurred in Cuba, and at the request of Cuban veterinary authorities several samples of Cuban virus were studied and all strains found to be alike and of the eastern type. Recommendation for control by vaccination with eastern type vaccine was made. A 4-page report with tables and maps on the 1944 outbreak of the disease in the United States was prepared and distributed to cooperating veterinarians, livestock sanitary officials, and other interested individuals.

Further evidence of the persistence and insidious nature of equine infectious anemia (swamp fever) was shown by the fact that blood of a symptomless carrier case in a horse originally infected in April 1935 was still infective when injected into two normal horses in January 1945, a period of approximately 9 years and 9 months. It was demonstrated by horse inoculation tests (1) that the virus in whole blood which had been dehydrated under high vacuum, while in the frozen state (lyophilization), was still fully virulent after storage in vacuum sealed glass ampoules at room temperature and in the light for a period of 32 months; (2) that virus in filtered serum collected from an acute case and held for 42 months in the refrigerator at a temperature of 5° to 10° C. was no longer virulent; (3) that a suspension of red blood cells from citrated blood collected from an acute case was still virulent and capable of setting of the disease in normal horses when injected subcutaneously after washing in physiological saline solution 6 times, laking by the addition of distilled water, and finally being subjected to repeated rapid shell freezing and thawing for 6 consecutive times. Additional evidence was obtained to indicate that the injection of antigens prepared from acetone-precipitated serum globulins from virulent blood did not constitute a reliable means of diagnosis. Studies on the use of the complement-fixation test as a means of diagnosis were continued. Antigens prepared by different methods from the red cells, bone marrow, heart, liver, kidney, and spleen of infected horses were tested against sera from known infected animals but only a small percentage of them gave positive reactions. Six million Oxford units of penicillin were administered intramuscularly within 40 hours to an actively acute case, during the third febrile attack with no beneficial results.

Studies were conducted in farm herds regarding the relative duration of immunity conferred by crystal violet-glycerol and crystal violet-phosphate hog-cholera vaccines. The results thus far obtained clearly indicate that the duration of immunity conferred by glycerol vaccines is at least as lasting as that obtained when phosphate vaccines are used. A patent, No. 2 369 267, was obtained on the crystal violet-glycerol vaccine, and all vaccines are now being produced by the crystal violet-glycerol method. The preparation of hog-cholera vaccine is based upon the observation that incubation at 37.5° C. for 2 weeks of virus containing crystal violet alone or in mixture causes the virus to lose its virulence but permits it

to retain its antigenicity. The effects of storage at refrigerator temperature was studied in a series of experiments in which portions of the same virus was treated with different chemicals, and then held at refrigerator temperatures, samples being removed from time to time and tested first for virulence and later for protective properties. Virulence, as determined by the injection of 1 cc. dose into susceptible pigs, was found to have disappeared from all samples after 6-1/2 months refrigeration. After 8 months refrigeration 10 cc. doses were used. No virulence was found in any of the refrigerated viruses, and all pigs injected with the 10 cc. portions remained well after later injection with virus. They had been immunized.

Investigations of non-infectious diseases of livestock and poultry: A phosphorus supplement has been used during the past season in areas where larkspur poisoning in cattle has been especially prevalent. The results, though far from conclusive, have indicated that considerable benefit was derived from the treatment. Reports received reveal a better state of nutrition in the cattle when brought from the range in the fall. The toxicity for cattle of Benoclor 3 Special which has been used in irrigation and drainage canals for killing aquatic plants was investigated, since cattle water in the canals. The recommended strength of the mixture for use in canals is approximately 66.84 parts per million. The toxic dose was found to be nearly 80 times that strength and the fatal dose about 3 times still greater or 16,666 parts per million. The results of these tests indicate that there is no risk involved, so far as livestock is concerned, when the recommended strength of this material is used in canals.

Two types of hormones, estrogenic, consisting of diethylstilbestrol and estradiol dipropionate, and gonadotropic, consisting of pregnant mare serum and sheep anterior pituitary extract, have been used to treat sterility in cattle. The sterility cases have consisted of cows that fail to come in estrus after calving, cows that exhibit estrus at irregular intervals but fail to conceive when bred, cows that exhibit estrus at regular intervals but fail to conceive when bred, and cows that exhibit more or less constant estrus or nymphomaniacs.

Investigations of protozoan parasites of livestock and poultry, including coccidiosis: In studies on chemical treatment for the control of anaplasmosis of cattle, it was determined that the most satisfactory criteria for determining the effects of drugs on the progress of this disease are (1) decrease in the numbers of anaplasms in the blood in the early stages of infection; (2) the response of the blood-forming organs in regenerating the blood lost; and (3) the general condition of the host. Twenty-one experimental infections were treated during the early stages of the parasitic attack with a total of 10 combinations. Of the treatments used, two-potassium arsenite and sodium arsenite-singly or in combination with other drugs showed the greatest promise. Mapharsen also appeared to be of some promise but the other drugs were of little or no value. Blood transfusion was found to be useful in the treatment of the severe anemia produced by the disease.

Progress was made in adapting to the diagnosis of anaplasmosis a highly specialized technique developed during the war for the detection of human malaria. A continuation of field studies in Kansas showed that anaplasmosis occurred every month during the year 1944, 66 percent of the cases appearing in August, September, and October. In further investigations of insect vectors of anaplasmosis it was found that the horn fly failed to transmit the disease from a sick to a susceptible animal.

Investigations on the control in cattle of genital trichomoniasis--a venereal disease caused by microscopic animal parasites that localize in the reproductive system--were conducted in cooperation with owners of beef and dairy herds. The program with beef cattle involved (1) withdrawal of all infected bulls from service; (2) termination of natural breeding and substitution therefor of artificial insemination, using semen from an uninfected bull; (3) resting all non-pregnant females for at least two months subsequent to their last coitus with an infected bull and (4) medicinal treatment of non-pregnant females whose condition was amenable to treatment. When the herd was returned to natural breeding 27 females had been served and all became pregnant. Only 34 services were required to achieve these pregnancies; the average sterile period per pregnancy was only about 9 days. Moreover, no new bulls have become infected, and cows that were previously infected have, with few exceptions, calved normally.

In a grade dairy herd where genital trichomoniasis was present, a program similar to that outlined for the beef herd was used, except that artificial insemination was not practical and was not used. An uninfected grade bull was used as the herd sire, in lieu of artificial insemination. After completion of one successful pregnancy following service by the clean, grade bull, the cows were served by a purebred bull. By the spring of 1945, 49 cows had been served and 41 diagnosed as pregnant. A total of only 69 services were required to impregnate the 41 cows, the average sterile period per pregnancy being only about 3 weeks.

Progress toward the development of a medicinal treatment for the cure of the disease in bulls through the destruction of the microscopic parasites is indicated by the results obtained with sodium and potassium iodides. Two infected bulls were treated successfully with 276 and 200 grams, respectively, of potassium iodide, given by mouth. Three other infected bulls were treated successfully with intravenous injections of 150, 225, and 375 grams of sodium iodide. In five other infected bulls the treatment was unsuccessful.

Studies were made on lambs that were infected experimentally with the organisms that produce coccidiosis. It was determined that the microscopic parasites, known as coccidia, localize in cysts immediately under the intestinal lining, where they multiply. The crop of organisms that results from the process of multiplication gets into the intestine through the rupture of the cysts, and moves down to the

lower portion of the gut. Here the organisms enter the cells lining the large intestine. Observations on heavily infected lambs showed that when the cysts rupture to liberate the coccidial organisms into the intestine, the small capillary blood vessels near the cysts also rupture, thereby producing intestinal hemorrhage.

Investigations were continued to determine the value of sulfa drugs for the prevention and control of cecal coccidiosis in chickens. Two sulfa drugs, namely, sulfamerazine and sulfamethazine, were tested during the year. These drugs were administered with the mash, in the proportion of one pound of drug to 99 pounds of mash. It was determined that the medicated feed benefited only those birds that had access to it not later than 3 days after inoculation with coccidia. The birds that were given medicated mash not later than 2 days after inoculation were protected to a marked extent. The benefit derived from the treatment was shown by reduced mortality and reduced numbers of blood-stained droppings, as compared to those in inoculated control birds that were given only regular mash.

Investigations of worm parasites of livestock and poultry, such as tapeworms, flukes, and roundworms: Strongyles, or blood worms, common parasites of horses and mules, are an ever-present threat to the health and working efficiency of their hosts. Early enthusiasm over the highly efficient action of phenothiazine against these parasites was soon tempered by the knowledge that the drug as customarily administered was sometimes poorly tolerated. Important strides have since been made toward safer methods of administering the drug to horses without sacrificing materially the efficacy of the treatment. The first was a reduction in the standard dosage from 50 to 30 grams for adult, average-sized, animals. Next was the development of the method of giving the drug in divided doses in feed, the usual dose being 5 grams of phenothiazine daily for 6 days. Finally, tests of the free-choice administration of phenothiazine and salt, a method of parasite control which has been unusually successful with sheep and goats, have shown some promise of an adaptability of this scheme of treatment to horses.

During the year investigations were continued on the removal of parasites from horses and on the prevention of reinfestation with these pests through self-medication with a phenothiazine-salt mixture in the ratio of one part of the drug to about 40 parts of salt. Although the amount of phenothiazine consumed on the average was not as great as that needed for the most effective control of parasites, the control achieved by the regime outlined was satisfactory from a practical standpoint. One horse, kept alternately on medicated salt and plain salt for varying periods, illustrates well the effects of this scheme of self-medication. When the animal had access to plain salt, cultures of its feces showed numerous strongyle larvae, indicating that adult worms were present in the intestine and that the pasture was being contaminated with potential parasites. When given access to medicated salt, the numbers of the

larvae in the feces began to decrease and gradually reached a very low level. This indicated that the adult worms were being gradually expelled and as a consequence the pasture was not being contaminated with potential parasites to any appreciable extent, especially towards the last.

During the past year an experiment was carried out to determine the influence of diet on the course of hookworm disease in lambs. Many field studies of this disease suggest that naturally-acquired infections are sometimes far more damaging than those usually produced experimentally. Moreover, the lambs used in experimental work are usually well fed, whereas the herbage available to grazing flocks is sometimes relatively innutritious, especially during certain seasons of the year and during periods of drought. Accordingly, a study was made to test the possibility that the diet of lambs may influence the severity of hookworm disease.

Lambs fed on adequate diet, consisting of grain and alfalfa hay, and lambs on a poor diet, consisting of timothy hay, were exposed experimentally to equal numbers of hookworm larvae under exactly the same conditions. The lambs on the adequate diet became definitely anemic but survived the injury caused by their hookworm infections. The infected lambs on the poor diet lost weight progressively, became extremely anemic and weak, and died in from 2 to 3 months after infection. Two uninfected lambs on the poor diet (timothy hay) neither lost weight nor became anemic. It appears, therefore, that diet is of paramount importance in determining the condition and survival of lambs that are heavily infected with hookworms.

Previous investigations designed to develop control measures for swine parasites through improved feeding practices showed that feeding skim milk afforded effective protection against the acquisition of large roundworms or ascarids, nodular worms, and whipworms. Pigs so fed made satisfactory weight gains and remained in good condition throughout the test. During the past year this investigation was continued, substituting whey for skim milk. The pigs were kept under conditions of constant exposure to infection. One group of pigs was fed whey once a day, at the time of the usual afternoon feeding; another group was fed whey exclusively for 3 consecutive days at intervals of 2 weeks; and the third group was fed only a balanced grain ration. Bi-weekly examinations revealed that the pigs receiving whey remained free of the parasites named, whereas those fed exclusively on grain became heavily parasitized with large roundworms, nodular worms, and whipworms. From the evidence so far adduced it is clear that the feeding of skim milk or of whey in the manner outlined will protect pigs from acquiring the intestinal parasites that are most injurious to them.

An investigation on the control of swine parasites in the Coastal Plain area of the South has been in progress since 1941, the work being done in cooperation with the Georgia Coastal Plain Experiment Station, Tifton, Ga. An analysis of the data collected up to June 30, 1945, showed that a combination of good feeding and sanitary

practices holds in check some of the most injurious of the internal parasites of swine. Large intestinal roundworms or ascarids, intestinal threadworms (Strongyloides), whipworms, and lungworms were effectively controlled in suckling pigs by farrowing on fields vacated since the previous season, and by providing a good grazing crop as well as a balanced supplemental ration. These parasites were controlled after weaning by moving the pigs in succession to areas planted to field crops. The frequency of rotation from pasture to pasture varied with the time that it took the pigs to consume the crop on a given area. After weaning the fall pigs were removed to a temporary pasture of green oats and were given supplemental feed consisting of shelled corn, protein supplement, and minerals. Other steps of importance in the control of internal parasites of swine were (1) adequate pastures to eliminate overcrowding of the pigs and (2) growing an ensilage crop on the winter grazing area. The spring and fall pigs raised as outlined were ready for market when they were 6 to 8 months old.

Investigations on liver flukes of cattle in the Gulf Coast region showed that treatment with the hexachlorethane-bentonite suspension --developed through research conducted in this Bureau during the past three years--affords a practical means of controlling these injurious parasites. In selected areas where herds have been treated experimentally twice a year since 1943, in cooperation with the owners, there has been, on the whole, a gradual decrease both in the incidence and degree of infestation. Moreover, examination of the snail intermediate hosts in one area where systematic treatment of cattle has been practiced, showed a marked decline in infestation with the larval stages of the fluke.

An investigation was made of a number of yearling and adult range cattle and dairy cows that had been treated with the hexachlorethane-bentonite suspension. The results showed that treatment was most efficacious in the yearlings. In the older animals with severely damaged livers the treatment was much less effective. To prevent the extensive liver damage that inevitably results from infestations of long standing, calves should be treated periodically to remove the flukes before they injure the liver seriously.

Tests were made to determine the efficacy of the hexachlorethane-bentonite suspension for the removal of liver flukes from sheep. Out of 110 known infected sheep treated with 30 cc. of the suspension, only 6 contained liver fluke eggs in their droppings several days after treatment. The number of eggs found in these 6 sheep were materially reduced, however, indicating that many of the parasites had been expelled by the medication. Autopsies performed on 4 infested sheep that had received the medication showed that 3 of the animals were entirely free of liver flukes and that one had only 3 flukes, probably acquired sometime after treatment.

A survey was made of sheep parasites on the Northern Plains to ascertain the conditions that lead to the acquisition of stomach worms, and intestinal roundworms known as trichostrongyles. It was

determined that the ewes carry fairly heavy loads of these worms at the time they drop the lambs. From the evidence collected during the spring of 1945 it appears that lambs placed on summer range that had been unoccupied by sheep during the winter and early spring made much better early weight gains and were in better physical condition than comparable lambs on range that had been grazed throughout the year. Moreover, rotation of sheep on the range appeared to prevent the acquisition of excessive numbers of parasites. However, the development of a scheme of range management to prevent the acquisition of parasites can only be developed through sustained, all-year round investigations on the range.

Tests were made with chickens and turkeys to determine whether the feeding of mash medicated with phenothiazine would keep the birds free of cecal worms. Autopsies of the treated birds showed them to be free of mature cecal worms but not of immature ones. Untreated control birds had mature as well as immature cecal worms. It is reasonable to conclude, therefore, that chickens receiving the medicated mash acquired cecal worms, which were expelled, however, when or shortly after the worms became mature. Approximately 50 percent of the treated birds and 75 percent of the untreated ones developed blackhead. Since this disease is transmitted through the eggs of the cecal worm as well as in other ways, it is possible that at least one avenue of transmission could be barred by feeding medicated mash, which is designed to eliminate the adult worms before they produce many eggs.

Tests were made also to determine whether a medicated mash containing nicotine-sulphate and phenothiazine would remove from chickens intestinal roundworms and cecal worms. The medicated mash was fed for 3 days in succession. At autopsy, 24 treated birds harbored a total of 3 intestinal roundworms, 437 of these parasites having been removed by the treatment; they harbored also 47 immature cecal worms, 1,696, mostly mature ones, having been removed by the treatment. Eleven untreated birds which served as controls eliminated no worms; at autopsy they were found to harbor a total of 472 intestinal worms and 1,107 cecal worms. The treatment was, therefore, highly effective as well as easy to administer.

Investigations of miscellaneous parasites of livestock and poultry: A study was made to determine whether the existing requirements for the sterilization of beef suspected of harboring tapeworm cysts are adequate to protect the public against acquiring tapeworms. Under existing regulations the meat must be refrigerated for a period of not less than 6 days at a temperature not higher than 15° F. Tests conducted in meat packing establishments in Chicago involved refrigeration of infested loins at the approximate temperature mentioned, for 5 and 6 days, respectively. Repeated microscopic examination of tapeworm cysts isolated from the meat so refrigerated showed no evidence of vitality. When infested beef trimmings were stuffed in 100-pound fiber boxes held at temperatures ranging from 12° to 20° F., some of the tapeworm cysts showed evidence of vitality after a holding period of 7 days.

Under meat inspection procedure sterilization by heat of meat infested with tapeworm cysts may be used in lieu of refrigeration. In the past meat so sterilized was heated to 170° F. In order to obtain precise information on the degree of heat necessary to kill tapeworm cysts, heating tests were made on several hundred cysts isolated from infested beef. Moreover, pieces of meat containing these cysts were heated to various temperatures, after which the cysts were removed and examined for signs of vitality. The results showed conclusively that heating to 131° F. was not sufficient to completely devitalize the parasites but that heating to 133° brought about their complete destruction.

During the year a survey was made, in cooperation with ranchers of South Dakota and Montana and with officials of the South Dakota Wildlife Service to determine whether species of parasites occuring in the prong horn antelope on the Northern Plains are transmissible to sheep. The results showed that antelopes harbor 7 species of intestinal parasites that are transmissible to sheep. These parasites, all roundworms, are known to be injurious to sheep, and their occurrence in the antelope may be of importance from the standpoint of parasite control in range sheep.

The Index Catalogue of Medical and Veterinary Zoology was maintained, as in previous years, and used extensively by various medical agencies of the Government, including those of the armed forces, as a source of information on tropical parasitic diseases. It was used, moreover, in connection with the Bureau's work in connection with exotic parasites and parasitic diseases that have not as yet gained a foothold in this country. Publication of the catalogue, suspended in 1942, was resumed during the year following the receipt of requests for its continued publication from the Surgeon Generals of the Army and Navy and from medical authorities outside the Government.

Investigation of treatments for parasites of livestock and poultry: In view of the increasing interest among farmers and ranchers in a practical plan of cattle grub control, a small area east of Colorado Springs, Colorado, having 120 square miles and a total of 2,295 cattle, was selected for testing grub control on an area basis. In January and February 1945 all the cattle in the area were treated with a standard medicated wash made up on the basis of 12 ounces of cube powder (4.4 to 5 percent of rotenone content) and 3 ounces of soap per 100 gallons of water. Six to 10 days after treatment all grubs were removed from about 10 percent of the treated cattle. A second extraction of grubs from the same cattle was made 34 to 41 days after treatment. A third extraction was made 7 weeks after treatment. Of the total number of grubs secured in the three extractions, somewhat over 95 percent were dead.

During the heel fly season in March and April, repeated inspections were made of the cattle in the area and comparatively few heel flies were seen molesting the animals. This work is being continued to determine the time necessary to achieve eradication of grubs on a limited area.

In New Mexico an experiment was begun during the spring of 1945 to determine whether the application of DDT to the skin and hair coat of cattle during the heel fly season will have any effect on the grub population during the coming winter months. Various suspensions of DDT, containing from 2 to 3 percent of this chemical, were applied as sprays to certain cattle within a herd; the treated cattle have been identified by ear tags. All tagged animals, treated twice during the heel fly season, will be carefully and repeatedly examined during the winter months and their grub populations compared to those in the herd that were not treated.

Tests were made to ascertain the effectiveness of DDT in destroying lice on hogs as well as preventing reinfestation. A 0.1 percent suspension of this chemical destroyed all the lice within 3 hours after treatment. The lice eggs, however, survived the treatment, hatched in the course of a few days, and the swine acquired a new crop of lice which survived. When DDT in a 0.5 percent suspension was applied to louse-infested swine, the egg as well as the lice were evidently killed since no live lice were found on the treated animals as late as 30 days after treatment.

Tests were made with DDT suspensions in dips for the destruction of sheep ticks. Small flocks of sheep were dipped in suspensions containing 0.1 percent of DDT and examined repeatedly after treatment for live ticks, with consistently negative results. A large flock of sheep in New Mexico, consisting of approximately 1,500 ewes and lambs, was dipped in a suspension of 0.15 percent DDT. Several weeks after dipping about 150 lambs were examined for live ticks; only 5 infested ones were found, each containing only a single live tick. Since the suspensions used were imperfect, it is probable that some of the DDT particles were screened out by the sheep as they passed through the vat. By using somewhat larger concentrations of DDT than those tested, or by improving the quality of the suspensions, the efficacy of this chemical for the destruction of sheep ticks probably can be raised to 100 percent.

In view of the large measure of success obtained by sheep growers in keeping parasitic infestation in their flocks at low levels by allowing the animals free access to a mixture of phenothiazine and salt--a scheme of self-medication first developed by parasitologists of this Bureau--cattlemen have been inquiring whether a similar scheme of self-medication will control parasites in calves. Experiments showed that mixtures of phenothiazine and salt were unsatisfactory for parasite control in calves. However, mixtures of phenothiazine with mineral supplements hold considerable promise.

Seven calves were given free access for a period of about 6 months to a mineral mixture containing 5 percent phenothiazine. For the first 55 days the animals were fed timothy hay and grain. The average consumption of the mixture was 33 grams per animal. When alfalfa was substituted for the timothy hay for the next 55-day period, the average daily consumption of the medicated mixture was only 11 grams per animal. The calves were then changed back to

timothy hay for a period of 68 days; the consumption of the medicated mineral mixture increased to about 22 grams per animal per day. Examinations of the droppings of the animals subjected to this regime of treatment showed that the amount of phenothiazine consumed while the calves were on timothy hay was adequate for the most part to control parasites, but that it was inadequate while the animals were fed alfalfa. It is evident, therefore, that the consumption of the medicated mineral mixture was materially influenced by the diet of the animals, a factor that must be further explored before a scheme of self-medication for the control of parasites on calves can be formulated.

In some sections of the country sheep and goat raisers "salt" their animals at about weekly intervals. This suggested the possibility of substituting for plain salt, salt medicated with phenothiazine as a means of controlling parasites. A number of goats were divided into three relatively equivalent groups. One group was given once a week a mixture of phenothiazine and salt in the ration of 1 to 7; another group was given continuous access to phenothiazine and salt in the usual ration of 1 to 10; and a third group was given access to plain salt. Both schemes of medication afforded protection from gross parasitism but the animals that had continuous access to the medicated salt contained fewer parasite eggs in the droppings than those that received medicated salt once a week. Seven goats that had access to salt alone contained at autopsy a total of 3,700 stomach worms, 88 hookworms, and 56 nodular worms, whereas 10 goats that received medicated salt weekly had at autopsy a total of 322 stomach worms, 11 nodular worms, and no hookworms. The goats that had access at all times to medicated salt were not killed for post-mortem examination but were used in other experiments.

For a number of years the choice of drugs for the removal of large intestinal roundworms, or ascarids, from swine has been oil of chenopodium and phenothiazine. Oil of chenopodium removes about 75 percent of these parasites, on the average, but the drug is difficult to administer and frequently proves toxic. Phenothiazine removes less than 50 percent of these parasites, has the advantage of easy administration, but is not substantially less toxic than oil of chenopodium. The need for a more satisfactory drug than either one mentioned has been apparent for some time and the work with sodium fluoride appears to indicate that it will become the drug of choice for the removal of these injurious parasites from swine. At the minimum dosage tested, namely, 1 percent of the chemical in the feed for one day, it removed, under carefully controlled conditions, 97 percent of all the ascarids harbored by 52 cull pigs. Vomiting and diarrhea were observed occasionally. Trials made in the field on 58 additional pigs in good condition, using a 1 percent concentration of the drug in the feed for periods of one or two days, resulted in the removal of an average of about 90 percent of the roundworms harbored. In these trials there was no evidence that vomiting and diarrhea were caused by the treatment, since these two conditions were observed in both treated and untreated animals.

Filariasis in sheep--a disease caused by roundworms the adults of which localize in the arteries and the larvae in the skin of the head, face, and occasionally in that of the hind feet and abdomen--was treated experimentally during the year with various antimony compounds. One compound, antimony potassium tartrate (tartar emetic), was injected at weekly intervals in 0.3 gram doses for 8 weeks in succession. In other tests the medication was injected twice a week for a period of 4 weeks. Either method of medication resulted in complete healing of the skin lesions produced by the larval worms. Another compound, sodium antimonyl tartrate with trypan blue, was injected in 15 cc. doses at weekly intervals for 8 weeks. A third compound, lithium thiomalate, was injected at weekly intervals in 6 cc. doses for the first 5 weeks and in 9 cc. doses for the next 5 weeks. Both drugs so injected healed the skin lesions.

(Continued on next page)

(d) Eradicating Tuberculosis and Bang's Disease

Appropriation Act, 1946 (including $800,000 reappropriation)		$5,848,000
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+430,000
Total anticipated available, 1946		6,278,000
Budget estimate, 1947		6,750,000
Change for 1947:		
Overtime decrease	-57,840	
Increase	+529,840	
.....		+472,000

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Eradicating tuperculosis in livestock (including poultry)	$1,350,048	$1,490,000	$1,690,000	+$200,000(1)
2. Eradicating Bang's disease in cattle	4,005,673	4,730,160	5,060,000	+329,840(2)
3. Overtime pay	411,425	57,840	- -	-57,840
Covered into Treasury as miscellaneous receipts, Public Law 529	304	- -	- -	- -
Unobligated balance	63,961	- -	- -	- -
Total available	5,831,411	6,278,000	6,750,000	+472,000
Transferred to "Salaries and expenses, Office of Information, Dept. of Agriculture".	+780	- -	- -	
1944 balance available in 1945	-343,959	- -	- -	
1943 balance available in 1946	- -	-800,000	- -	
Anticipated supplemental .	- -	-430,000	- -	
Total estimate or appropriation (1945 adjusted for comparability	5,488,232	5,048,000	6,750,000	

INCREASES AND DECREASES

The net increase of $472,000 in this item consists of the $57,840 decrease for overtime, and the following:

(1) An increase of $200,000 under the project "Eradicating tuberculosis in livestock (including poultry)," composed of:

(a) $194,000 to cover additional operating expenses and indemnity payments for the eradication of tuberculosis in livestock (including poultry).

Objective and Need: In cooperation with the State livestock sanitary officials and cattle owners in the 48 States, Alaska, Hawaii, and Puerto Rico, to conduct long-overdue retests for tuberculosis, both in individual herds and modified accredited areas.

In each of the past 2 years there has been an increase in the percentage of reactors to the test for tuberculosis. For several years there has been a shortage of trained veterinary personnel and it has not been possible to meet the testing schedules for modified accredited tuberculosis-free counties due for reaccreditation. There is no question but that failure to retest at regular intervals means a greater percentage of reactors when the retests are finally made, and the percentage increases as the interval between tests widens. It is therefore imperative, if the gains made in previous years are to be maintained, that retesting work be pushed to the maximum extent possible consistent with the availability of trained veterinary personnel. As additional veterinarians become available, the tuberculosis-eradication program will be brought up to schedule and the danger of reinfection reduced to a minimum.

(b) $6,000 for placing on a full-year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(2) An increase of $329,840 under the project ("Eradicating Bang's disease in cattle,") composed of:

(a) $312,000 to cover additional operating expenses and indemnity payments for eradicating Bang's disease in cattle:

Objective and Need: In cooperation with the State livestock sanitary officials and cattle owners in the 48 States and Puerto Rico, to conduct overdue retests for brucellosis (Bang's disease) and take up new work in additional herds and cattle that have been on the "waiting list" for some time.

In each of the past 2 years there has been an increase in the percentage of reactors to the test for brucellosis. A shortage of trained veterinary personnel has interfered with the necessary retesting of herds and areas. With additional veterinary assistance available, this work can be brought up to date and the necessary attention given to new work.

Additional veterinarians and nonprofessional employees will be assigned to work in the States where they are most needed. There is a great demand for the work in practically all sections of the country, both as it pertains to retesting of herds and areas, and the inauguration of new work in areas in which very little, if any, testing has heretofore been conducted.

(b) $17,840 for placing on a full-year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

CHANGE IN LANGUAGE

It is proposed that the following language be deleted, since the estimates for the fiscal year 1947 do not contemplate a reappropriation:

"* * * together with not to exceed $800,000 of the unobligated balance of the appropriation for the fiscal year 1943 * * *"

Resume of Financing and 1946 Allotment:

Tuberculosis eradication has been in progress since 1917. During the fiscal years 1935 to 1938, inclusive, regular and special funds (Jones-Connally and Section 37, Act of August 24, 1935) were used for this purpose. Bang's disease eradication was inaugurated in the fiscal year 1935, and this work was financed exclusively with special funds through the fiscal year 1938. Since 1939 the Agricultural Appropriation Act has provided for continuation of tuberculosis and Bang's disease eradication under one consolidated appropriation item entitled "Eradicating tuberculosis and Bang's disease."

Table 1, which follows, shows the direct appropriations, reappropriations of regular and special funds, and net availability under the consolidated item.

Statement of Direct Appropriations, Reappropriations of Regular and Special Funds, and Net Availability under "Eradicating Tuberculosis and Bang's Disease." Fiscal Years 1939-1947.

Fiscal year	Direct appropriation	Reappropriation	Total appropriation	Amount reappropriated in subsequent years	Net availability
1939	$5,403,000	1/ $7,827,000	$13,230,000	$4,000,000	$9,230,000
1940	8,300,000	1/ 4,000,000	12,300,000	5,450,000	6,850,000
1941	4,300,000	1/ 4,000,000	8,300,000	750,000	7,550,000
1942	5,598,140	2/ 750,000	6,348,140	- -	6,348,140
1943	3,575,669	3/ 2,463,331	6,039,000	800,000	5,239,000
1944	5,983,800	- -	5,983,800	343,959	5,639,841
1945	5,433,232	4/ 343,959	5,777,191	- -	5,777,191
1946	5/ 5,478,000	6/ 800,000	5/ 6,278,000	- -	6,278,000
1947est.	6,750,000	- -	6,750,000	- -	6,750,000

1/ Estimated unexpended balance of special funds (Jones-Connally and Section 37, Act of August 24, 1935).
2/ Unobligated balance of 1941 funds under this head.
3/ $1,450,000 unobligated balance of 1940 funds under this head and $1,013,331 unexpended balances of appropriations heretofore made for "Eradication of Foot-and-Mouth and Other Contagious Diseases of Animals."
4/ Unobligated balance of 1944 funds under this head.
5/ Includes $430,000 anticipated supplemental for additional costs as a result of the Federal Employees Pay Act of 1945.
6/ Unobligated balance of 1943 funds under this head.

WORK UNDER THIS APPROPRIATION

Objective: To eradicate tuberculosis in livestock (including poultry), paratuberculosis in cattle, and Bang's disease (brucellosis or contagious abortion) in cattle, and to provide partial compensation to owners of cattle condemned and destroyed because of being affected with the diseases.

The Problem and its Significance: Tuberculosis is one of the most serious diseases of cattle, swine, and poultry, because of its effect in reducing production and causing a considerable loss of meat condemned as unfit for food. It is also a menace to the public health, as it may be transmitted to children using unpasteurized milk and dairy products from infected cows, causing tuberculosis of the glands and bones. Much has been done in eliminating bone tuberculosis, which frequently manifests itself in humans as hunchback, by the eradication of tuberculosis in cattle. Notwithstanding the great progress made in stamping out this disease, it is reliably estimated that an annual loss of $10,000,000 can be attributed to it, $5,500,000 of which is borne by the poultry industry, $2,000,000 by the swine industry, and $2,500,000 by the cattle industry. In swine it may progress to a point where it becomes generalized, but in most of the carcasses showing evidence of the disease on post-mortem examination, only slight lesions are found. Avian (fowl) tuberculosis is particularly difficult to eradicate because of the fact that the organisms are so resistant and live for many months in the soil.

Bang's disease is found among cattle in practically all sections of the United States, although the degree of infection is much greater in some localities than in others. In those sections where there has been a considerable exchange of cattle, a high degree of infection is found. This condition also obtains in and around the large milk-shed areas. It is conservatively estimated that this disease is responsible for an annual loss of $30,000,000 to our livestock industry. Approximately 75 percent of all breeding trouble in cattle is caused by this disease, the principal effects of which are (1) abortion or premature birth of calf; (2) reduction in the production of milk; (3) retention of fetal membranes, with very serious results; (4) sterility or failure to breed successfully; and (5) predisposition of newly-born calves to other serious diseases, especially such diseases as scours and pneumonia, and at times, mastitis.

In recent years it has been proved that undulant fever in man is caused by the same germ that causes Bang's disease in cattle. A considerable number of such cases have been reported which resulted from the ingestion of Bang's disease germs in raw milk. Handling pork products coming from animals infected with Bang's disease is also a means of transmitting undulant fever to man.

General Plan--Cooperation with States: Eradication work is conducted in cooperation with livestock sanitary officials of the various States, and is governmed by state laws and regulations. Tuberculosis eradication is carried on under the test-and-slaughter plan, but cooperating States may elect one or more of the three plans for Bang's disease eradication: (a) test-and-slaughter plan; (b) test-and-slaughter with calfhood vaccination; and (c) test-and-retention of reactors, with calfhood vaccination.

Under the test-and-slaughter plan, tests are applied to the cattle by veterinarians employed by the Bureau, states and counties, and by practicing accredited veterinarians, to detect the existence of any infection in the living animal. Reactors are appraised at their market value, taking into consideration their quality as breeding and dairy animals, after which they are slaughtered under supervision. In addition to their salvage value, the owner receives from the Federal Government one-third of the difference between the appraised value and the salvage, not to exceed $25 for grade animals and $50 for registered purebred animals. Federal payment is further limited to an amount not exceeding that paid by the cooperating state, county, and municipality. Payment from all sources, including the salvage, cannot exceed the appraised value of the animal.

Under the test-and-slaughter with calfhood vaccination plan, all cattle over 6 months are usually tested. The vaccination of animals is confined to calves between 4 and 8 months of age, 6 months being the preferable age. The age and date of vaccination of each animal is properly recorded, and the identity of each animal definitely established. Animals in herds in which vaccination is practiced are not to be disposed of, except for immediate slaughter, without written permission of the cooperating state or Bureau officials. A herd under the vaccinal plan may be certified as a "herd Free of Brucellosis" for a period of 1 year when all animals in the herd over 2 years of age reveal at least 2 negative reactions to official blood agglutination tests, properly spaced, and the vaccinated animals under 2 years of age show a satisfactory blood titer. The payment of Federal indemnity for adult cattle in such herds that react to the test depends upon the circumstances in the individual states.

Under the test-and-retention of reactors, with calfhood vaccination plan, the owners of herds practicing calfhood vaccination are permitted to hold reactor cattle under strict quarantine until they can be replaced by healthy animals. The milk from such animals is, of course, properly pasteurized. No Federal payment will be made for these reactors at any future date.

Supervision is maintained over the disposition of reactors which have been consigned to public stockyards for slaughter, and over the testing at such stockyards of cattle to be shipped interstate for dairy or breeding purposes.

In combating avian tuberculosis, the veterinarians employed in the field cooperate with the local livestock sanitary officials and the owners of poultry flocks. Cooperation is also obtained from certain local organizations and owners of hatcheries.

Progress and Current Programs:

Eradicating tuberculosis in livestock (including poultry): In 1917, the year the cooperative campaign to eradicate tuberculosis in livestock was inaugurated, it was estimated that approximately 5 percent of all the cattle in the United States were affected. In some localities, however, the incidence was much greater than in others. As a result of the continued retesting of herds and cattle, the removal of reactors for slaughter, and the cleaning and disinfecting of infected premises, the infection of the disease has been reduced to 0.24 percent of the entire cattle population. This is a slight increase over the infection reported for the past 2 years and emphasizes the importance of conducting the necessary retesting of cattle in individual herds and areas in order that any reactors may be located and removed. This retesting has been hampered considerably by the shortage of trained veterinary personnel, a considerable number of whom have been in the armed forces. Through the fiscal year 1945 the Federal Government had expended approximately $97,000,000 in the eradication of this disease. The various States, counties, and territories have contributed an additional $153,000,000.

Notwithstanding the combined efforts of Federal and State veterinarians and others interested in the work, there was a slight increase in the incidence of tuberculosis reported on post-mortem examination of swine slaughtered during the fiscal year 1945 at official establishments operating under Federal meat inspection. Of the 49, 468,458 swine slaughtered at such establishments during the year, over 7 percent showed some evidence of tuberculosis and were retained for further inspection. On each hog retained, excluding those that were later sterilized or condemned, there was an average loss of 65 cents at current wholesale values, or a total waste of pork and pork products amounting to approximately $2,300,000. Adding the loss under State and city inspection, it would exceed $4,000,000. Of those retained for further inspection, 12,440 entire carcasses, representing more than 1,300,000 pounds of pork, were condemned as unfit for food. An additional 10,396 carcasses, or about 1,100,000 pounds, were passed for sterilization. Just 10 years ago, of a total slaughter of approximately 34,413,000 swine under Federal supervision, 10.8% were retained for further inspection as showing some evidence of tuberculosis. Of that number, 52,687 entire carcasses were either condemned or sterilized. It is interesting to note that although more than 15,000,000 more hogs were slaughtered under Federal supervision in 1945 than in 1935, considerably less than one-half as many carcasses were condemned or sterilized.

During the fiscal year 1945 Federal, State, and county veterinarians engaged in the tuberculin testing of cattle in sections of the country where avian tuberculosis exists observed approximately 35,900 poultry flocks containing about 5,085,000 fowls, located in 8 States. In addition, about 12 veterinarians employed by the Bureau devoted practically their entire time to the avian work. These men, working with organizations interested in the poultry industry, State livestock sanitary officials, and local veterinarians, visited 9,525 farms and inspected 1,464,063 fowls. Infection was reported on 621 farms. These employees, further, applied the tuberculin test to 270,086 fowls, disclosing 7,751, or 2.8 percent, reactors. Cooperation on the part of owners of poultry and others interested in this phase of the work continues to be good.

Work in connection with the eradication of Johne's disease (paratuberculosis) was continued. Although this disease is not widespread, it does exist to a slight extent among cattle in many States and is difficult to control. During the fiscal year 1945, cattle tested for the disease numbered 3,896, of which 243, or 6.2 percent, reacted.

Supervision of the disposition of cattle reacting to the tuberculin test, which had been consigned to public stockyards for slaughter, and the supervision of the tuberculin testing of cattle at such stockyards that are to be moved interstate for dairy or breeding purposes, was continued. All the tuberculin used in official cooperative tuberculosis-eradication work is prepared by the Bureau. That this diagnostic agent be uniform and effective is of the utmost importance. During the year the Bureau prepared approximately 732,000 cc. of this product.

From the standpoint of the cattle owner who has had his cattle condemned, the payment of indemnity to assist him in securing the necessary replacements to maintain a healthy herd is of paramount importance. The average Federal payment for condemned cattle is practically the same as it was 10 years ago, although the State payment has more than doubled during that period. State and county appropriations for indemnity purposes amounted to more than $1,000,000 during the fiscal year 1945, while an additional sum of more than $3,050,000 was provided by such agencies for operating expenses.

Eradicating Bang's disease (Brucellosis) in cattle: Brucellosis of cattle, also called Bang's disease and infectious abortion, is an infectious, usually chronic, disease. Its principal effects are five in number, as follows:

(1) It results either in an abortion or causes premature birth of the calf.
(2) It reduces milk production.
(3) It causes retention of fetal membranes with very serious results.
(4) It often causes sterility or failure to breed successfully.
(5) It may predispose newly-born calves to other serious diseases, especially such diseases as scour and pneumonia.

Surveys made in 1935 indicated that approximately 10 percent of the cattle in the United States were affected with the disease and that it was prevalent in all parts of the country. The tremendous loss incurred by the livestock industry (in 1942 it was estimated at approximately 30 million dollars annually) is thus apparent. In addition to its effect on the livestock industry, Bang's disease in cattle has a considerable bearing on public health. That this is recognized by the U. S. Public Health Service is evidenced by the fact that the Standard Milk Ordinance of that Service requires that cattle supplying milk for cities within its jurisdiction pass a negative test for Bang's disease unless the milk is pasteurized.

During the more than 40 years in which Bang's disease in cattle has been investigated in this and other countries, most of the essential factors in connection with the nature of the disease have been established. Methods of control have also been established but, unfortunately, none are easy of operation or inexpensive. As a result, very little was actually accomplished in this line until the fiscal year 1935, when the Bureau, in cooperation with several States, inaugurated a control program based on the test-and-slaughter method of eradication. Since that time very satisfactory progress has been made in the reduction of the disease with the exception of the past 2 years when, due to the demands of the military service, it has been impossible to maintain sufficient veterinary personnel to conduct the necessary retesting and take up new work. During the fiscal year 1945 the infection disclosed, as a result of conducting approximately 5,213,000 tests, was 4.7 percent, which represents a slight increase over the infection disclosed during the past several years.

In December 1939, a plan of establishing modified accredited Bang's disease-free areas, that is, areas in which cattle infection does not exceed 1 percent and herd infection not more than 5 percent, was inaugurated. Despite the shortage of trained veterinary personnel, fairly satisfactory progress has been made. When conditions are such that it will be possible to increase the force of veterinarians, much valuable work in connection with the program can be accomplished as there is a great demand for the work in practically all sections of the country. At the close of the fiscal year 1945, a total of 599 counties in 22 States had qualified as modified accredited areas. These counties, which are approximately 20 percent of the total counties in the United States, contain about 5,626,000 dairy and breeding cattle. Area work looking towards accreditation is being conducted in about 165 additional counties. All the counties in North Carolina have so qualified, and several other States have more than 50 counties each in that classification.

Brucellosis, which is primarily a disease of breeding cattle, is preventable with reasonable certainty by the use of vaccine in conjunction with sanitary precautions and good herd management. It has been demonstrated that the vaccination of calves in dairy herds commonly leads, a few years later, to substantially greater milk

yield per cow and greater total production due to less mortality among calves. During the past fiscal year very satisfactory progress was made in the use of brucella vaccine made from strain 19 of that organism in calves between the ages of 4 and 8 months. This work is conducted under official supervision to some extent in practically all the States. During that period 501,114 calves between the ages of 4 and 8 months were vaccinated, the total number vaccinated since the project was inaugurated in January 1941, being 1,271,991. It will be noted that of the total calves vaccinated ruing the entire 4½ years approximately 40 percent were vaccinated during the fiscal year 1945. Of the 243,050 reactors disclosed during the fiscal year 1945, 86,738 were retained under strict quarantine in herds practicing calfhood vaccination. When they outlive their usefulness as dairy or breeding animals and the vaccinated calves come of age, such reactors are slaughtered without Federal indemnity. The milk from such animals is, of course, properly pasteurized.

Continued study and some progress was made in the vaccination of adult cattle in a limited number of herds in which satisfactory progress in the eradication of the disease has not been made under the test-and-slaughter plan. Research conducted by the Bureau indicates that vaccination is as effective in adult cows as it is in calves, but the agglutination blood titer usually remains high for a much longer time than it does in calves. This persistence of titer interferes with the control program which is based on the agglutination blood test.

Careful supervision of the testing of all vaccine used in this work was continued. During the past year samples of 3,213 batches of commercially prepared vaccine was tested by the Bureau, of which 244, or 7.59 percent, were found unsatisfactory and ordered destroyed. Some of the vaccine used in official work is prepared by the Bureau, as well as all the antigen used in official Bang's disease testing.

The supervision of the disposition of Bang's disease reacting cattle at public stockyards, to which they had been shipped for slaughter, was continued.

The payment of Federal indemnity for cattle condemned and slaughtered on account of Bang's disease continues to be an important feature of the campaign to eradicate this disease, as it assists the owners of such cattle in purchasing the necessary replacements to establish and maintain healthy herds. During the fiscal year 1945 State and county appropriations for indemnity purposes amounted to more than $2,800,000, while an additional sum exceeding $2,100,000 was also made available for operating expenses. Only 7 States failed to provide indemnity funds, although 6 of those made varying sums available for operating expenses.

(e) Inspection and Quarantine

Appropriation Act, 1946	$999,600
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945	+140,000
Total anticipated available, 1946	1,139,600
Budget estimate, 1947	1,125,000
Change for 1947:	
Overtime decrease -22,561	
Increase +7,961	-14,600

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
Bureau of Animal Industry:				
1. Scabies eradication	92,125	114,900	115,720	+820
2. Control over interstate shipment of livestock for the purpose of preventing the spread of communicable disease	337,475	362,294	364,867	+2,573
3. Determination by inspectors in the field of the existence of diseases	24,060	59,500	59,930	+430
4. Inspection and quarantine of import animals	114,873	124,800	125,690	+890
5. Supervision over the importation of hides and other animal byproducts	64,689	71,400	71,910	+510
6. Inspection and testing of animals for export	6,645	20,000	20,140	+140
7. Eradicating cattle ticks	187,426	219,900	221,460	+1,560
8. Control of hog cholera and related swine diseases	97,407	114,900	115,720	+820
9. Portion of funds for enforcement of 28-hour law retained by Bureau of Animal Industry to cover cost of services performed for Production and Marketing Adm. on that Project	16,500	18,700	18,850	+150
10. Overtime pay	162,615	22,336	--	-22,336
Covered into Treasury as miscellaneous receipts, Public Law 529	78	--	--	--
Unobligated balance	36,413	--	--	--
Total available, Bureau of Animal Industry	1,140,306	1,128,730	1,114,287	-14,443

(Continued on next page)

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
Production and Marketing Administration:				
11. Enforcement of the 28-hour law	11,458	10,645	10,713	+68
12. Overtime pay	2,193	225	- -	-225
Covered into Treasury as miscellaneous receipts, Public Law 529	3	- -	- -	- -
Unobligated balance	710	- -	- -	- -
Total available, Production and Marketing Administration	14,364	10,870	10,713	-157
Total available	1,154,670	1,139,600	1,125,000	-14,600(1)
Anticipated supplemental	- -	-140,000	- -	
Total estimate or appropriation (1945 adjusted for comparability)	1,154,670	999,600	1,125,000	

INCREASES OR DECREASES

(1) The net decrease of $14,600 in this item for 1947 consists of the $22,561 decrease for overtime and increases totaling $7,961 (as reflected in the project statement) for placing on a full-year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(Continued on next page)

WORK UNDER THIS APPROPRIATION

Objective: (a) The control and eradication of hog cholera and related swine diseases, scabies in sheep and cattle, dourine in horses, and the cattle fever tick, in cooperation with the various States; the investigation of reported outbreaks of diseases among livestock to determine if they are communicable and, if so, assisting local authorities in their control and eradication; (b) the application of tests in the field and in the laboratory for diagnostic purposes; (c) the control over interstate movements of livestock as a means of preventing the dissemination of infections, which includes inspection at the principal market centers; (d) the administration of the 28-hour law to prevent cruelty to animals in interstate transportation; (e) the inspection and testing of livestock intended for export, to determine their freedom from disease, and the inspection of fittings and accommodations on vessels on which they are to be transported; (f) the inspection and quarantine of livestock offered for importation; (g) control over import animal byproducts, hay and straw, etc., to prevent the introduction or dissemination of communicable livestock diseases; and (h) the administration, jointly with the Treasury Department, of Section 306 of the Tariff Act of 1930, prohibiting the importation of domestic ruminants or swine, or chilled or frozen fresh meats derived therefrom from countries where foot-and-mouth disease or rinderpest exists.

The Problem and its Significance: Scabies and the other diseases covered by this item are readily disseminated and their control or eradication is important for the protection of the livestock industry.

Shipment of livestock which are affected with a communicable disease may cause other animals to become infected and thus cause severe loss to livestock owners. The discovery at public stockyards of shipments of livestock affected with communicable diseases prevents the further spread of disease and permits the infection to be traced back to its source.

It is important to safeguard the livestock industry against serious losses by preventing the introduction of destructive communicable diseases from other countries through the importation of livestock or through the medium of infected or contaminated animal byproducts, hay, straw, etc. In order to protect and promote foreign trade it is necessary to prevent the exportation of any animals that have been exposed to any communicable disease and to provide for the safe transportation of those animals which may be exported.

Through enforcement of the 28-hour law, animals in interstate transportation receive humane treatment, arrive at destination in better condition, and have a lower death rate while in transit. Shrinkage in weight is also reduced, resulting in a corresponding saving in the meat products produced from the livestock.

General Plan--Cooperation with States: Disease control and eradication work is carried on in cooperation with the States involved. In public stockyards work, an inspection force is maintained at principal market centers to prevent the dissemination of livestock diseases by detecting, segregating, and supervising the appropriate treatment or other disposal of animals affected with or exposed to contagious, infectious or communicable disease, and supervising the treatment and disinfection of all cars, trucks, and other conveyances used in the transportation of infected animals, and all pens, chutes and alleys in which such animals are handled. In the import work under this item inspectors are assigned to stations along the international boundaries and on the seacoast to inspect animals, and when necessary to place them in quarantine, and to inspect animal byproducts, hay, straw, etc. In export work, animals are inspected and tested at ports and in the various districts of origin throughout the country.

With respect to the 28-hour law, records of the railroads are examined in certain localities to find violations. Such violations are then reported to Washington where they are analyzed. The railroads are notified of the apparent violation and invited to present any additional information if they think there was an excusable reason for the violation. Then the cases are prepared and sent to the Department of Justice for handling through the Courts. When time permits, feeding stations are inspected to see that they are adequate and railroad representatives are contacted to find ways of preventing future violations. It is the desire of the Department to reduce violations to a minimum rather than allow conditions to exist which will bring an ever-increasing number of violations.

Progress and Current Program:

Scabies eradication: During the fiscal year 1945 inspections and supervised dippings of sheep in the field totaled 7,637,168 and 305,103, respectively. Infection was found in 586 flocks which was nearly 24% less than for the previous year. All but a comparatively few of the infected flocks were located in Louisiana and in midwestern farm States. In all the cooperating States, except Louisiana where circumstances have made it necessary to defer systematic dipping, satisfactory progress has been made. A few cases of reinfestation in areas where the disease had been completely eradicated were promptly dealt with.

Cattle scabies eradication work was continued, with 1,551,991 inspections in the field and 73,593 dippings supervised. A few cases were found in previously infected areas in Nebraska and in an adjoining State, showing the need for continual vigilance to guard against the spread of undiscovered infection. The Bureau also assisted in handling a few cases of sarcoptic mange in several widely separated States.

Control over interstate shipment of livestock for the purpose of preventing the spread of communicable diseases: During the fiscal year 1945 our inspection forces at public stockyards disclosed 319 diseased lots of cattle, sheep, and swine, involving 13,210 animals, exclusive of animals which reacted to the test for tuberculosis or brucellosis. These forces are making every effort to prevent the spread of livestock diseases by the prompt detection of animals affected with communicable diseases, and immediately treating the animals and the premises and the transporting vehicles in a manner which will minimize the danger of spreading the infection. They also furnish information to the State livestock sanitary officials which aids them in eradicating the disease at point of origin.

During the year, the Bureau continued to cooperate with the War Department in protecting the health of its horses and mules by assigning experienced employees to supervise the cleaning and the disinfection of cars and other vehicles and stockyard pens and equipment used in the handling and the shipment of these animals from concentration points to Army posts and from Army posts to various locations where maneuvers were being held.

Inspections at Public Stockyards

	1944	1945	Estimated, 1946	Estimated, 1947
Number of stockyards operating	48	45	45	49
Located in cities	46	43	43	47
Animals inspected:				
Cattle	23,412,083	26,587,725	27,000,000	26,500,000
Sheep	29,150,427	27,686,313	27,500,000	28,000,000
Swine	45,152,111	28,274,940	23,000,000	35,000,000
Total animals inspected	97,714,621	82,548,978	77,500,000	89,500,000
Animals dipped and immunized:				
Cattle dipped	1,707	3,112	3,000	3,000
Sheep dipped	288,908	167,148	167,000	200,000
Swine immunized	438,166	274,312	350,000	400,000
Total animals dipped and immunized	728,781	444,572	520,000	603,000
Infectious cars received	372	289	300	320
Cars cleaned and disinfected	3,296	2,934	3,200	3,500

The above figures are not fully indicative of the amount of work involved for the reason that a very large percentage of livestock movements are by motor truck rather than by railroad. More work is required in the inspection of truck shipments than in the inspection of shipments

received by rail. In order to keep pace with this increased truck movement most of the stockyards have been compelled to divide their larger pens into smaller pens suitable for holding a few animals each. This has the effect of slowing down our inspection work since it is necessary for our employees to enter each pen to make a proper examination of all animals received in the yards. At one of our largest stockyards this subdivision of pens in the sheep division has reduced the natural light to such an extent that it has become necessary for our employees to examine each animal with the aid of a flashlight during practically the entire day, which has a decided slowing effect on inspection activities.

Determination by inspectors in the field of the existence of disease: In continuing the cooperative work with the State authorities to determine the existence of dourine of horses satisfactory progress was made. Work in the field consists of drawing blood samples from all horses in the areas involved and forwarding serum from each sample to Washington for complement-fixation test in the Bureau's laboratory. All horses found by the test to be affected with dourine are destroyed. The disease appears to be eradicated in the previously infected areas of California and Nevada. The only infection disclosed was in the State of Arizona on one of the Indian reservations where the work is carried on in cooperation with the Office of Indian Affairs. The operations are costly because most of the horses in the infected area are wild range animals difficult to gather and handle, especially under the topographical and climatic conditions of the region. Of the nearly 7,677 horses tested only a fraction of 1% were found to be affected with dourine and destroyed. The disease exists in the same general region in the Republic of Mexico and the Bureau continued its cooperation with Mexican authorities in testing over 500 horses of which 69 were adjudged reactors and destroyed.

Bureau employees continued to furnish assistance in administering preventive treatment to Indian owned cattle on reservations where anthrax infection is known to exist. Prompt and careful investigation was made of all reports of cases suspected of being foot-and-mouth disease.

Inspection and quarantine of import animals: All livestock offered for importation were inspected to determine their freedom from disease, as provided by law. Over 680,000 head of livestock were inspected at the various ports of entry, which is more than twice the number inspected in the previous year. During the year 10,305 head of livestock were refused entry on account of disease and a few were detained for further observation and testing for the purpose of determining their freedom from infection. The number and kind of animals inspected during the fiscal year 1945 were as follows:

Ports of entry	Cattle	Swine	Sheep	Goats	Horses and mules	Asses	Others
Ocean ports	- -	- -	78	5	53	1	10
Canadian border ports	65,790	606	233,731	119	18,733	2	38
Mexican border ports	357,077	86	1,812	4	2,019	88	9
Total	422,867	692	235,621	128	1/ 20,805	91	57

1/ Of this number 154 were mules.

Supervision over the importation of hides and other animal byproducts, forage, etc.: Under this project during the fiscal year 1945, supervision was exercised over the entry of various animal byproducts, hay and straw, which may be the means of introducing the infections of livestock diseases. The very large volume of such products included more than 90,000,000 import hides and skins, of which over 3,000,000 proceeded from countries where foot-and-mouth disease or rinderpest exists. All railroad cars, trucks, and premises involved in the transportation and handling of restricted import products were disinfected.

Inspection and testing of animals for export: During the fiscal year 1945 a total of 86,206 animals were inspected prior to exportation in accordance with Department regulations and in order to meet the requirements of destination countries. The export inspections have increased materially during the past two years and inspections during the year represent more than three times the number of the previous year. Control was exercised over the equipment and facilities of vessels receiving export livestock to assure the provision of space and fittings necessary for humane treatment and safe transportation. In the fiscal year 1945, the number and kind of animals inspected for export were as follows:

Kind of Animals	To Canada	To Mexico	To other Countries	Total
Cattle	85	8,746	2,834*	11,665
Swine	3	25,593	2,511**	28,107
Sheep	8	25,744	1,066	26,818
Goats	6	12,500	93	12,599
Horses	219	933	2,438	3,590
Mules	2	193	3,040	3,235
Asses	- -	88	39	127
Other animals	48	17	- -	65
Total	371	73,814	12,021	86,206

*86 Canadian cattle included in this number.
**18 Canadian swine included in this number.

Eradicating cattle ticks: The cattle fever tick is the only natural carrier of the disease splenetic or tick fever of cattle and with its elimination this disease is eradicated and the costly quarantine restrictions and other losses chargeable to this parasite are removed. Most of the country formerly infested is now tick-free. Practically all cattle in continental United States are now non-immune to tick fever and, therefore, must be protected from this tick if losses from this disease are to be avoided.

At present the principal danger of reinfestation is by the introduction of fever ticks on stray or smuggled animals from Mexico. All Mexican territory adjacent to the international boundary along the lower Rio Grande is fever-tick-infested. In adjacent areas in the United States it has been necessary to maintain and patrol a buffer quarantined area on a narrow strip of Texas country along this border from Del Rio, to the Gulf of Mexico. On several occasions during the past year fever ticks were brought into that area on Mexican livestock and on at least one occasion, notwithstanding precautionary measures taken by the Bureau and the cooperation of other Government agencies, smugglers using tick-infested horses crossed the quarantined strip and entered the free area of Texas, thus exposing parts of four counties to reinfestation.

Under the supervision of Bureau employees and cooperating agencies engaged in this project 7,796,315 inspections and dippings of cattle and 524,664 inspections or dippings of horses and mules were conducted.

Considerable reinfestation remains in Puerto Rico and an extensive dipping campaign is being conducted on that island. In addition to cattle, horses, and mules, it was necessary to treat sheep and goats on infested premises and 387,727 inspections or dippings of these animals were made.

No change was made during the year in the area held under Federal quarantine. Of the 985 counties in 15 Southern and Southwestern States under Federal quarantine in 1906, when tick eradication was first undertaken, 977 have been released and the 8 remaining counties containing quarantined area are located along the Mexican border in Texas.

Control of hog cholera and related swine diseases: Hog cholera is present in practically all sections of the country. It continues to be the most serious and costly ailment of swine and where it is not kept under control hog producers suffer enormous losses. Swine erysipelas, especially in the Corn Belt, appears to be becoming more prevalent and there is a growing demand for experienced veterinary assistance in its diagnosis and to prescribe effective control measures. Usually but one veterinarian is assigned to this project in a State and there is, therefore, a large demand for the services of these employees to advise how swine ailments may be avoided, to correctly diagnose disease when it occurs, and to recommend the control measures that should be taken.

Enforcement of the 28-hour law (Production and Marketing Administration): While the movement of livestock by rail in fiscal year 1945 did not increase materially over that of the previous year, more violations were reported. Because of changes in schedules, railroads have developed and put into use facilities for resting, watering and feeding animals at points not generally used in the past. As a result of extra tolerance due to wartime adversities, only about 50 percent of the cases reported were prosecuted during the war years compared with approximately 75 percent during the period before the war.

During the past year visits were made to a large number of livestock markets and feed-in-transit stations to observe the enforcement work and confer with officials of the railroads and stockyards. Records were examined to obtain information regarding the loading and unloading of livestock. Measures to obtain this information on shipments destined to points not yet covered by this service are being developed.

During the last year 2,181 violations on the part of the railroads were reported. Investigation was completed in 1,175 cases leaving at the first of the year a backlog of more than 1,000 cases--almost as many as can be processed with existing resources during the entire current year. Of the violations investigated last year 651 were sent on for prosecution, and 524 did not warrant court action because failure to comply with the law was, in each case, unavoidable. Advice was received during the year on the disposition of 626 cases by the courts in which penalties aggregating $66,000 were imposed; that is an increase of 23 percent over the $53,600 imposed in the fiscal year 1944.

The following table shows the violations, convictions and penalties for the last four fiscal years:

Item	Fiscal Year			
	1942	1943	1944	1945
Violations reported	757	1,916	2,138	2,181
Violations referred to Solicitor	504	613	795	651
Violations referred to Department of Justice	473	442	866	512
Cases terminated during year	299	511	542	649
Cases pending end of year	328	256	773	697
Number of convictions	280	455	490	626
Amount of penalties	$29,750	$48,050	$53,600	$66,000

(f) Meat Inspection

Appropriation Act, 1946	$7,800,000
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945	1,590,000
Total anticipated available, 1946	9,390,000
Budget estimate, 1947	9,160,000
Change for 1947:	
Overtime decrease	-230,000

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
Production and Marketing Administration:				
1. Meat inspection operations at plants under the Federal meat inspection service	$7,642,341	$8,984,652	$8,984,652	- -
2. Determination of adulterations and other objectionable conditions in meat and meat food products by laboratory analysis	93,200	108,500	108,500	- -
3. Inspection of imported meats and meat food products	31,066	35,400	35,400	
4. Overtime pay	1,564,556	229,462	- -	-229,462
Covered into Treasury as miscellaneous receipts, Public Law 529	153	- -	- -	- -
Unobligated balance	28,978	- -	- -	- -
Total available, Production and Marketing Administration	9,360,294	9,358,014	9,128,552	-229,462
Bureau of Animal Industry:				
5. Chemical, pathological, and zoological investigations relating to meat inspection	25,497	31,448	31,448	- -
6. Overtime pay	4,287	538	- -	-538
Covered into Treasury as miscellaneous receipts, Public Law 529	1	- -	- -	- -
Unobligated balance	2,045	- -	- -	- -
Total available, Bureau of Animal Industry	31,830	31,986	31,448	-538
Grand total available	9,392,124	9,390,000	9,160,000	-230,000

(1) Decrease of $230,000 due to elimination of overtime.

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
Transferred to "Salaries and expenses, Office of Information, Department of Agriculture"	+10,100	- -	- -	
Anticipated supplemental	- -	-1,590,000	- -	
Total estimate or appropriation (1945 adjusted for comparability)	9,402,224	7,800,000	9,160,000	

(1) Decrease of $230,000 due to elimination of overtime.

(Continued on next page)

WORK UNDER THIS APPROPRIATION

Objective: The major purposes of the present system of meat inspection are (1) to examine food animals including cattle, sheep, swine, goats, and horses prior to slaughter to eliminate diseased animals; (2) to conduct a thorough post mortem examination of each animal at the time of slaughter to search out and eliminate diseased and otherwise unfit meat; (3) to destroy diseased and otherwise unfit meat; (4) to see that meat and meat products are kept clean and wholesome during the stages of preparation into articles of food; (5) to guard against the use of harmful preservatives and other deleterious ingredients; (6) to cause sound and wholesome meat and meat products to be marked as having been "inspected and passed"; (7) to require informative labeling and to prevent the use of false and deceptive labeling on meat and meat products; (8) to certify meat and meat products for export; (9) to inspect meat and meat products offered for importation into this country; (10) examine meat and meat products for compliance with specification requirements of governmental purchasing agencies and (11) to assure proper post-mortem diagnosis and dispostion of carcasses in unusual cases; to conduct research on methods of treatment of carcasses and tissues to meet requirements of meat inspection regulations; and to conduct research on abnormal conditions in meat or its products through investigations of suspected feeding, management, or packing procedures or of diseases or parasites to which the conditions might be attributed.

The Problem and Plan of Work:

(1) In connection with Meat Inspection Service: The Meat Inspection Service has for many years been an important and fundamental influence in the production, marketing, and distribution of livestock and meat and meat products. Since approximately 7-½ percent of all animals slaughtered for food are affected with some abnormal or diseased condition which is seldom apparent except to especially trained inspectors, it is necessary that such inspectors examine individually each animal slaughtered for food purposes. Also, meat and meat products being highly perishable and readily contaminated, their processing, preparing, and packing must be conducted in adequately equipped plants under close inspectional supervision.

Condemned meat and meat products must be destroyed under strict supervision to prevent their use as human food and to prevent their contaminating other meat and meat products during handling.

To assure the wholesomeness of processed meat and meat products it is necessary to control the use of ingredients going into their preparation. These are also inspected for wholesomeness and only those are permitted to be used which are fit and will in no way affect adversely the wholesomeness of the meat and meat products.

All labels used at inspected establishments on meat and meat products must be approved in advance of their use. Labels are required to inform the purchaser concerning the articles on which they are used. Also a label is not permitted to be used if it contains any false or misleading statement or other feature.

Foreign countries accept meat and meat products from this country only if Federally inspected and passed and identified as such. Export shipments are identified with special meat inspection export stamps. To meet the requirements of certain countries, however, special meat inspection certificates are also furnished. This background of inspection for American export meat and meat products has maintained an open market for these products throughout the world.

Under the Import Meat Act and the Meat Inspection Act, the Secretary of Agriculture may determine what meat and meat products may be offered for import by countries having a national system of inspection which is the substantial equivalent of the system amintained in the United States. Each consignment is carefully inspected to ascertain that only meat and meat products which have been properly certified from abroad are accepted and that they are sound, wholesome, and otherwise fit for food and truthfully labeled. Through this procedure imported meat and meat products are required to comply with the same standards as those for similar domestic products.

(2) In connection with related research: It is imperative that proper diagnosis be made of diseased or other questionable conditions encountered in food-producing animals at the time of slaughter. This prevents the distribution of any unwholesome meat or meat products to the general public or to our armed forces and Allies and assists in the conservation of our meat supply. To accomplish this, an immediate investigation is required of unusual biochemical, pathological, and zoological conditions or symptoms which inevitably arise. It has not been necessary to establish special laboratories for this purpose inasmuch as highly specialized facilities which may be utilized with a minimum of cost and a maximum of efficiency have been available for many years in the Bureau of Animal Industry.

Examples of Progress and Current Programs:

Meat inspection operations at packing plants: During the war the demands of the Army, Navy, Lend-Lease, and other agencies for inspected meat and meat products, coupled with increased civilian demands, required extension of the inspection service from 679 plants in 1942 to 1,050 plants in 1945, an increase of 54.5 percent. This includes 629 plants under inspection prior to the war, 270 plants that successfully qualified for full inspection during the war, and 151 plants under partial inspection. The 151 plants under partial inspection in 1945 involved only supervisory cost since the inspectors at these plants were actually detailed by the Army to perform regular meat inspection service. Several of these plants have applied for full inspection and it is anticipated that there will be some net addition to the inspection load from this source during the next year. Already the majority of the 270 plants that qualified for full inspection during the war have requested that the inspection be continued at their plants for an indefinite period.

Approximately 70 percent of all meat animals killed annually are slaughtered and processed under Federal inspection. It is estimated that about one-half of the remainder are slaughtered by farmers on the farm. Although

the number of cattle and calves inspected during fiscal year 1945 continued to increase, the total number of all species of animals inspected decreased from the all time high of 118,101,636 in 1944 to an estimated 94,370,711 in 1945, which approximates 1943 and is 9,000,000 more than in 1942. The decline in 1945 from 1944 resulted from the drop in hog production below the record level of the previous year. The decline in total ante-mortem and post-mortem inspections in 1945 was largely offset by (1) the extension of inspection service to 1,050 establishments, a new high, in 393 cities and towns (compared with 944 establishments in 363 cities and towns in 1944), (2) the slaughter of over 1,600,000 more cattle under Federal inspection in 1945 than in 1944, and (3) the increased volume of products totaling more than 200,000,000 pounds in 1945 examined for compliance with purchase specifications for other Government agencies.

The tables which follow indicate the volume and scope of the meat inspection activities.

Number of Establishments Covered

Fiscal Year	Establishments	Cities and Towns
1941	668	257
1942	679	264
1943	842	336
1944	944	363
1945	1,050	393

Animals Inspected, Ante-Mortem and Post-Mortem

Ante-Mortem Inspection

Fiscal Year	Animals Passed	Animals Suspected	Animals Condemned	Total Animals Inspected
1941	81,818,138	243,005	31,763	82,092,906
1942	85,777,095	251,804	34,291	86,063,190
1943	95,156,504	248,981	43,511	95,448,996
1944	117,769,389	276,458	55,789	118,101,636
1945	94,130,084	262,347	46,922	94,439,353

Post-Mortem Inspection

Fiscal Year	Carcasses Passed	Carcasses Condemned	Total Carcasses Inspected
1941	81,799,343	262,848	82,062,191
1942	85,749,940	278,012	86,027,952
1943	95,082,760	320,778	95,403,538
1944	117,656,285	387,774	118,044,059
1945	94,028,231	361,269	94,389,500

Disturbed market conditions under which immature calves and cattle in poor flesh have been sent to market have caused the percentage of condemnations to increase since 1943. This, of course, has placed an additional burden of vigilance on the inspection service to detect and eliminate unwholesome carcasses.

Inspection of Animals by Species

Ante-Mortem Inspections

	1941	1942	1943	1944	1945
Cattle	10,131,469	11,767,096	11,577,874	12,922,460	14,528,808
Calves	5,396,483	5,548,431	5,093,324	6,280,148	7,677,057
Sheep and Lambs	17,817,588	18,555,117	21,817,259	23,852,147	22,678,156
Goats	5,476	9,518	30,960	10,524	10,964
Swine	48,727,238	50,152,218	56,889,559	74,975,659	49,484,599
Horses*	14,652	30,810	40,020	60,698	59,769
Total	82,092,906	86,063,190	95,448,996	118,101,636	94,439,353

Post-Mortem Inspections

	1941	1942	1943	1944	1945
Cattle	10,126,861	11,761,746	11,572,285	12,915,664	14,518,519
Calves	5,393,566	5,544,745	5,089,331	6,273,537	7,667,156
Sheep and Lambs	17,811,612	18,547,305	21,804,016	23,837,737	22,664,800
Goats	5,452	9,498	30,891	10,503	10,893
Swine	48,710,059	50,133,871	56,867,080	74,946,117	49,468,458
Horses*	14,641	30,787	39,935	60,501	59,674
Total	82,062,191	86,027,952	95,403,538	118,044,059	94,389,500

*Horses are slaughtered and their meat handled and prepared in separate establishments from those handling cattle, calves, sheep, goats, and swine.

Processed meat and meat food products: Each type of meat processing requires the application of detailed inspection procedures by specialists to insure cleanliness, truthful labeling, and the utilization of pure and wholesome processing materials. The quantity of meat and meat food products prepared and processed under Federal inspection in 1945 was less than in 1944 due to the decline in inspected hog slaughter.

Meat and Meat Food Products Prepared and Processed Under Federal Inspection

Classified by Fiscal Years

Fiscal Year	Pounds
1941	10,514,837,866
1942	12,039,492,563
1943	14,292,716,225
1944	16,707,585,974
1945	13,408,978,079

Classified by Type of Product

Product	1944 Quantity (Pounds)	1945 Quantity (Pounds)
Placed in cure:		
Beef	134,123,636	105,995,196
Pork	4,033,981,189	2,806,340,563
Smoked and/or dried:		
Beef	53,160,412	57,599,760
Pork	2,367,808,744	1,832,666,162
Sausage:		
Fresh finished	400,669,726	482,693,309
Smoked and/or cooked	986,095,209	1,101,017,588
To be dried or semi-dried	138,249,645	145,436,630
Loaf, headcheese, chili con carne, jellied products, etc.	212,307,595	238,704,866
Cooked meat:		
Beef	35,226,730	32,001,488
Pork	485,662,979	369,791,177
Canned meat and meat food products:		
Beef	134,938,998	233,604,900
Pork	995,723,680	905,938,896
Sausage	215,572,407	210,943,237
Soup	286,095,549	292,735,653
All Other	489,267,128	714,455,038
Bacon, sliced	560,282,295	454,974,882
Lard:		
Rendered	2,339,028,779	1,424,657,052
Refined	1,804,245,765	1,163,382,544
Rendered pork fat:		
Rendered	255,208,641	143,801,698
Refined	141,102,201	86,624,177
Oleo Stock	148,565,173	121,405,231
Edible tallow	104,238,280	93,696,990
Compound containing animal fat	255,810,912	275,478,903
Oleomargarine containing animal fat	59,965,997	49,645,183
Miscellaneous	60,018,956	55,700,235
Horse Meat:		
Cured	- -	814,834
Chopped	10,235,348	8,871,887
Total	16,707,585,974 1/	13,408,978,079 1/

1/ This figure represents pounds inspected. Some of the products may have been inspected and recorded more than once due to having been subjected to more than one processing treatment, such as (1) curing and (2) canning.

Specification examination: During fiscal year 1945 the quantity of meat and meat food products examined by meat inspectors, for compliance with purchase specifications for other Government agencies on a reimbursable basis, increased 200,000,000 pounds -- 25 percent over the previous year, as indicated below:

Specification Examination of Meat and Meat Food Products

Branch of Government	Fiscal Year 1943	Fiscal Year 1944	Fiscal Year 1945
	(Pounds)	(Pounds)	(Pounds)
Navy Department	671,630,601	494,766,677	631,898,252
Commodity Credit Corp.(Lend-Lease)	13,778,853	292,123,169	425,161,608
Coast Guard	6,117,028	12,649,763	17,231,340
War Shipping Administration	3,614,129	3,912,419	4,164,486
Marine Corps	73,685,214	823,376	313,978
Department of Interior	870,600	708,556	656,633
Veterans Administration	1,590,133	620,825	568,134
War Department (Engineers)	357,035	279,224	181,988
Maritime Commission	207,900	209,052	575,686
Department of Justice	1,234,263	122,168	107,880
All others	587,399	- -	144,351
Total	773,673,155	806,215,229	1,081,004,336

The trend toward Federal inspection, together with a program for expansion of plant facilities in many of the regularly inspected establishments, has increased the number of sets of drawings and specifications of proposed construction from 561 in 1944 to 748 for 1945 which were submitted to the meat inspection service for approval.

Labels: Packers or processors are required by law to submit their labels for approval prior to use. In 1945, 14,063 new labels or sketches for proposed labels were submitted for approval--an increase of 573 over 1944. Actions taken are indicated below:

Item	Fiscal Year 1944	Fiscal Year 1945
Number of labels approved for use at official establishments	11,538	12,365
Number of labels approved for use on imported meat and meat food products	110	74
Number of labels, and proposed sketches of labels, returned unapproved	1,842	1,624
Total number of labels or sketches of lables submitted for approval	13,490	14,063

Certification of exemption: In 1945 a total of 44 certificates of exemption from inspection were issued to retail butchers and dealers who usually ship meats in intrastate commerce, and who desired to make interstate shipments. Periodic inspections were made of the premises of these butchers and dealers to assure that the meat and meat food products were produced under sanitary conditions and that meat inspection requirements were met.

The trend toward Federal inspection, together with a program for expansion of plant facilities in many of the regularly inspected establishments, has increased the number of sets of drawings and specifications of proposed construction submitted to the meat inspection service for approval from 561 in 1944 to 748 during 1945.

Prosecutions: Violations of the Act during the past fiscal year consisted principally of the transportation or offering for transportation of nonfederally inspected meat in interstate commerce. Prosecutions were obtained in 22 such violations requiring payment of fines ranging from $20.00 to $1,000 and totaling $5,485.

Chemical, pathological, and zoological investigations relating to meat inspection (Bureau of Animal Industry): In order to conduct on an efficient basis the inspection service at establishments operating under Federal meat inspection it is necessary that laboratory examinations and researches be conducted on disease problems in food-producing animals. Such work has continued to be conducted in the research laboratories of the Bureau. Several hundred specimens are received each year which have been collected at establishments located in various parts of the country. Through these diagnoses and researches determinations are made as to whether carcasses or parts of carcasses should be passed for human consumption and also whether procedures in effect at establishments operating under Federal meat inspection are such as to assure a product which is sound, healthful, wholesome, and fit for human food.

During the past fiscal year experiments were conducted to determine the survival time of trichinae in ground pork maintained at relatively low temperatures (37° to 42° F). The object of this work was to secure basic information that could be applied to the processing of dried summer sausage so as to make this product safe for consumption from a health standpoint. The results obtained confirmed the limited work done the previous year, and showed that trichinae in salted ground pork retain their infectivity for a period of 38 to 39 days; however, when the meat was fed 42 to 43 days after conservation in salt it produced no infection in rats--animals that are highly susceptible to trichinosis. It was observed in the course of these tests that the trichinae in salted meat retained slight vitality after 42 to 43 days, despite the fact that they were no longer capable of producing the disease trichinosis. This work is being continued to establish on a secure scientific basis the period necessary to completely destroy the vitality as well as the infectivity of these parasites.

Tests were made also to secure basic information on the time necessary to kill trichinae at temperatures below their thermal death point which is 131° F. Trichinae were isolated from meat heated to 122° F. and

maintained at that temperature for 1, 2, and 3 hours, respectively. Although signs of life were found in some larvae kept for 3 hours at 122° F., none of the parasites heated as specified developed when fed to rats, and these animals did not acquire trichinosis. Pieces of rabbit meat containing trichinae were heated to 122° F. and maintained at that temperature for 1, 2, 3, 4, and 5 hours, respectively. Some of the heated meat was then fed to groups of rats to ascertain whether the trichinae were still infective, and other pieces were digested artificially to free the trichinae for microscopic examination. The results showed that all the parasites were killed only in the meat kept at 122° F. for 5 hours; some of the parasites in meat so heated for 1 to 4 hours still were active. In the feeding tests with rats it was found that infection was produced with trichinous meat heated at 122° F. for 1 hour but not with that heated for 2 or more hours. It is evident, therefore, that when heated the parasites lose their infectivity before they are completely devitalized.

A hitherto unreported pathological condition affecting the musculature, tendons, fasciae, and livers of hogs was encountered. The condition was designated as progressive ossifying fibrositis. A similar disease is reported as occurring occasionally in children. In tracing the affected animals to their point of origin it was found that 27 pigs on three different farms were sired by the same boar, which also had a history of being affected with the disease. The evidence indicates that the disease occurred on the basis of an inherited predisposition or susceptibility.

At our pathological laboratory located in Chicago diagnoses were made on approximately 400 pathological specimens representing a great variety of miscellaneous diseases, infections, tumors, and other pathological conditions of livestock. Investigation of the cause of condemnation of about 350 calf carcasses at one establishment revealed the presence of hemorrhagic septicemia or shipping fever. A complete study was made of the history and shipping conditions, as well as the bacteriology and pathology of this outbreak.

(Continued on next page)

(g) Virus-Serum-Toxin Act

Appropriation Act, 1946		$243,400
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+40,000
Total anticipated available, 1946		283,400
Budget estimate, 1947		300,000
Change for 1947:		
Overtime decrease	-5,540	
Increase	+22,140	
		+16,600

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Control of manufacture, importation and shipment of viruses, serums, toxins, etc.	$241,304	$277,860	$300,000	$22,140
2. Overtime pay	44,512	5,540	- -	-5,540
Covered into Treasury as miscellaneous receipts, Public Law 529	12	- -	- -	- -
Unobligated balance	1,400	- -	- -	- -
Total available	287,228	283,400	300,000	+16,600(1)
Anticipated supplemental	- -	-40,000	- -	
Total estimate or appropriation (1945 adjusted for comparability)	287,228	243,400	300,000	

INCREASES OR DECREASES

(1) The net increase of $16,600 in this item for 1947 consists of the $5,540 decrease for overtime and increases totaling $22,140, as follows:

(a) An increase of $18,880 to provide for increased inspection and supervision of establishments licensed to produce veterinary biological products:

Objective: To insure that all veterinary biologics produced by licensees are, in fact, not worthless, contaminated, dangerous, or harmful, and to prevent, insofar as possible, the interstate movement or importation of any veterinary biologic product, organism, or vector that is worthless, contaminated, dangerous, or harmful.

The Problem and its Significance: Biological products that are not properly prepared and tested may be worthless, contaminated, dangerous, or harmful to animals treated therewith. They may either fail to prevent or control an outbreak of disease and may even be the means of spreading disease. A license issued by the Secretary should carry with it reasonable assurance to the livestock producers that the products when properly used will afford protection and not be harmful to his animals. A biologic product that is contaminated or otherwise improperly prepared, not only may endanger the herd that is treated, but may prove disastrous to other herds in the community. With a general upward trend during the past few years in the production of veterinary biologics, the inspection personnel of the Bureau has been hard pressed to maintain the desired supervision of all operations at licensed establishments. The point has already been reached where some operations must be permitted which can not be directly supervised. Information at hand indicates that the upward trend in production will continue for some years. Owners of plants producing veterinary biologics are planning enlargements of their facilities in order to take care of the constantly increasing demand which they anticipate will continue at least until the world's supply of meat and dairy and poultry products begins to stabilize. Available funds permit the employment of not to exceed 70 inspectors in the field to supervise operations at 72 licensed establishments located in 56 cities and towns.

Plan of Work: Additional inspection personnel will be assigned to six points where the staff is insufficient to maintain the standard of inspection desirable to assure maximum protection for the livestock producer, as follows:

Berkeley, California (including one substation at Petaluma): One man is now attempting to cover the work at both locations. There are four premises in Berkeley and one in Petaluma and an additional inspector is needed badly.

Denver, Colorado (including one substation at Colorado Springs): The work at these two points is being covered by 3.8 inspector man-years of service (0.2 of the time of one inspector is occupied by other work of the Bureau). Plants are at three locations in Denver and two in Colorado Springs. Production activity at one plant is such that two inspectors are needed at all times and two plants should have an inspector at each. Therefore, 4.8 inspector man-years of service are needed.

East St. Louis, Illinois (including substations at seven locations): Eight plants are involved. Two of the substations require an inspector at each and three inspectors are necessary properly to cover the work at the other six plants. Present funds permit the assignment of only four inspectors to this station.

Omaha, Nebraska (including substations at three locations): The work at these four points is being covered by 5.7 inspector man-years of service (0.3 of the time of one inspector is occupied by other work of the Bureau). Nine plants are under inspection,

one plant should have the services of three inspectors at all times, another plant has operations which require the full time of one inspector and a second inspector at times, two other plants require an inspector each. Therefore, two additional inspectors are required.

St. Joseph, Missouri (including one substation at South St. Joseph): Seven inspectors now cover the work at four plants, two of the plants being of a size calling for an inspector each and the other two plants having operations which require a total of six inspectors. Therefore, an additional inspector should be provided.

(b) An increase of $3,260 for placing on a full-year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(Continued on next page)

WORK UNDER THIS APPROPRIATION

Objective: To insure that all veterinary biologics produced by licensees are, in fact, not worthless, contaminated, dangerous, or harmful, and to prevent insofar as psssible, the interstate movement or importation of any veterinary biologic product, organism, or vector that is worthless, contaminated, dangerous, or harmful.

The Problem and its Significance: Biological products that are not properly prepared and tested may be worthless, contaminated, dnagerous, or harmful to animals treated therewith. They may either fail to prevent or control an outbreak of disease and may even be the means of spreading disease. A license issued by the Secretary should carry with it reasonable assurance to the livestock producer that the products when properly used will afford protection and not be harmful to his animals. A biologic that is contaminated or otherwise improperly prepared not only may endanger the herd that is treated but may prove disastrous to other herds in the community through failure of the product in some respect.

General Plan: This work involves the detailing of sufficient inspectors to the establishments producing anti-hog-cholera serum and hog-cholera virus so that all operations connected with the production and testing of these products are carried out under direct supervision. Inspection of plants producing biological products other than anti-hog-cholera serum and hog-cholera virus is made periodically or upon instructions for special reasons.

Volume of Work:

Item	Actual F.Y. 1945	Estimated F.Y. 1946	Estimated F.Y. 1947
(a) Establishments producing anti-hog-cholera serum and hog-cholera virus	40	40	40
Production:			
Serum (cc)	1,189,641,000	1,373,915,000	1,783,800,000
Virus (cc)			
Simultaneous	88,572,000	103,733,000	120,780,000
Hyperimunizing	222,660,000	274,740,000	333,120,000
Inoculating	1,091,000	1,271,000	1,534,000
Animal inspections	3,277,000	4,063,000	4,915,000
Tests supervised	14,177	17,580	21,030
(b) Establishments producing other biologics	40	40	40
Cc	351,751,000	449,087,000	537,621,000
Milligrams	34,129,000	42,092,000	51,193,000
Disks	512,000	639,000	768,000
(c) Products destroyed (all kinds):			
Cc	36,161,000	45,040,000	36,240,000
Milligrams	4,735,000	5,846,000	4,527,000
Disks	102,000	76,000	88,000
(d) Export certificates issued	675	843	690

Large stocks of veterinary biological products were carried over from the fiscal year 1944. The continuance of the European war during the winter of 1944-45 prevented a larger exportation of these products during the fiscal year 1945. The large production of anti-hog-cholera serum, hog-cholera virus, and other products during the fiscal year 1944, coupled with the decrease in swine production the next year, also contributed greatly to effect accumulation of large reserves. Lately demands for many biological products have increased and reserve stocks are now diminishing. Producers must increase production as soon as supplies and manpower are available if sufficient stocks are to be maintained to take care of expected home and foreign demands. The export demands for these products have increased now considerably over that of the fiscal year 1944 and undoubtedly will remain high until foreign countries are able to produce products for their own use. Even though livestock in this country may diminish in numbers, it is expected that an increase in the livestock of the world will strengthen the demand for biological products. Information at hand indicates that many licensees are planning to increase production materially as soon as conditions will warrant. Recently a number of licensed establishments have changed ownership, the purchasers being large organizations with established marketing facilities. Programs to take care of increased production are already under consideration by several of these large organizations.

(Continued on next page)

(h) Marketing Agreements, Hog Cholera Virus and Serum

Appropriation Act, 1946		$31,940 (a)
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+5,800 (a)
Total anticipated available, 1946		37,740 (a)
Budget estimate, 1947		37,300 (a)
Change for 1947:		
Overtime decrease	-970	
Increase	+530	
		-440

(a) Transferred from the unobligated balance of the appropriation provided by section 12(a), Title I, of the Agricultural Adjustment Act of May 12, 1933.

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Marketing agreements with respect to hog cholera virus and serum	$29,147	$36,770	$37,300	+$530
2. Overtime pay	5,933	970	- -	-970
Unobligated balance	3,364	- -	- -	- -
Total available	38,444	37,740	37,300	-440 (1)
Transfer from "Salaries and expenses, Agricultural Adjustment Administration"	-38,444	-31,940	-37,300	
Anticipated supplemental	- -	-5,800	- -	
Total estimate or appropriation	- -	- -	- -	

INCREASES OR DECREASES

(1) The net decrease of $440 for 1947 consists of the $970 decrease for overtime and an increase of $530 for placing on a full-year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(Continued on next page)

WORK UNDER THIS APPROPRIATION

Objective: To insure that the control agency and handlers of anti-hog-cholera serum and hog-cholera virus observe the provision of the marketing agreements and order.

The Problem and its Significance: The Serum and Virus Law of August 24, 1935, and Marketing Agreement of December 7, 1936, stress the economic importance of producers and other handlers maintaining an adequate supply of serum and virus at all times, and aim to prevent undue and excessive fluctuations of prices, unfair methods of competition, and unfair trade practices.

General Plan: The marketing agreement is enforced by a control agency selected by the Secretary and handlers, whose acts are subject to review by the Secretary and his representatives. The work related mainly to reviewing acts of the control agency, attendance at meetings, and the assembling of economic data relating to the production, sales, and prices of anti-hog-cholera serum and hog-cholera virus.

Progress and Current Program: The following table gives comparative figures by fiscal years on the number of handlers operating under the marketing agreement:

Item	Actual June 30, 1943	Actual June 30, 1944	Actual June 30, 1945	Estimated 1946 and 1947
Distributor-Handlers	199	199	207	210 (Each Year)
Producer-Handlers	38	38	37	38
Volume Contract Purchasers	5	7	9	10

This agreement has been entered into for the purpose of insuring an adequate supply of anti-hog-cholera serum and hog-cholera virus, stocks of which are diminishing. Adequate supplies of anti-hog-cholera serum and hog-cholera virus are essential in the routine immunization of swine and the furtherance of maximum hog production, and especially for use in any emergency arising from an extensive outbreak of hog cholera.

(i) Eradication of Foot-and-Mouth and Other Contagious Diseases of Animals

This item continues the availability of $305,000 of the unexpended balances of appropriations heretofore made for use in case of an emergency arising from an outbreak of foot-and-mouth or other contagious diseases of animals. A revision of the language covering use of funds for the control of European fowl pest and similar diseases in poultry is proposed. No expenditures are contemplated unless an emergency arises, but it is essential that funds be available at all times to insure immediate protection of the American livestock and poultry industries should outbreaks occur. This is particularly important under present world conditions. In many parts of the world there has been a complete breakdown of livestock sanitary requirements.

CHANGES IN LANGUAGE

The estimates include proposed changes in the language of this item as follows (new language underscored, deleted matter enclosed with brackets):

> In case of an emergency arising out of the existence of foot-and-mouth disease, rinderpest, contagious pleuropneumonia, or other contagious or infectious diseases of animals, or European fowl pest and similar diseases in poultry, which, in the opinion of the Secretary, threatens the livestock or the poultry industry of the country, he may expend in the city of Washington or elsewhere any unexpended balances of appropriations heretofore made for this purpose, not to exceed $305,000, in the arrest and eradication of any such disease, including the payment of claims growing out of past and future purchases and destruction [, in cooperation with the States,] of animals (including poultry) affected by or exposed to, or of materials contaminated by or exposed to, any such disease, wherever found and irrespective of ownership, under like or substantially similar circumstances, when such owner has complied with all lawful quarantine regulations: Provided, That the payment for such animals hereafter purchased may be made on appraisement based on the meat, egg-production, dairy, or breeding value, but in case of appraisement based on breeding value no appraisement of any such animal shall exceed three times its meat, egg-production, or dairy value, and, except in case of an extraordinary emergency, to be determined by the Secretary, the payment by the United States Government for any such animals shall not exceed one-half of any such appraisements: Provided further, That [of said $305,000 not to exceed $5,000 may be used to control and eradicate the European fowl pest and similar diseases in poultry] poultry may be appraised in groups when the basis for appraisal is the same for each bird

It is proposed that the language, "in cooperation with the States", relating to cooperation in effectuating the purposes for which the appropriation was made, be deleted.

The sole purpose of the proposed deletion of this language is to shorten and simplify the item. The phrase proposed for deletion is considered surplusage and, therefore, need not be retained in the annual appropriation

act, the cooperative work being authorized by the Department of Agriculture Organic Act of 1944 (21 U.S.C. 114a). Elimination of the language from the annual appropriation act will not--in any way--change the scope or character of the work performed under this appropriation item, or the authority of the Department to cooperate with other agencies, institutions, organizations, or others in the conduct of such work.

All of the remaining changes in language are explained in the following statement:

Recent developments with regard to communicable diseases of poultry indicate the possibility that at any time it may be necessary for the Bureau to participate in a campaign for the eradication of a communicable disease of poultry by the slaughter of diseased or exposed birds and the payment of indemnity to owners. Such a campaign would be conducted only in the event the disease was of such a nature as to threaten the poultry industry of the country and would be handled somewhat the same as the campaigns of the past for the eradication of foot-and-mouth disease in livestock.

It is proposed to delete the proviso authorizing the use of not to exceed $5,000 to control and eradicate European fowl pest and similar diseases of poultry, and to enlarge the scope of the emergency provision of the language to include authority for the use of any part of the $305,000 carried from year to year, under this appropriation item, in the arrest and eradication of European fowl pest and similar diseases in poultry.

Newcastle disease, formerly non-existent in this country, has been diagnosed in poultry in two seaboard States, one on the Atlantic and the other on the Pacific. This disease, like European fowl pest, is caused by a filterable virus and experience in foreign countries has shown it to be highly contagious and destructive. Generally speaking, such situations call for prompt action to eliminate the infection if methods have been developed by which that can be achieved, the object being to prevent dissemination which would result in the disease becoming established in the country. Experience elsewhere indicates that in the case of Newcastle disease complete eradication can be accomplished most effectively and promptly through slaughter of affected and exposed flocks, followed by thorough disinfection of the premises. This is exactly the method pursued in outbreaks of foot-and-mouth disease among ruminants and swine and, as in the latter, would involve the indemnification of owners. The adoption of such a program of eradication to eliminate the centers of disease is under study by the interests and agencies concerned.

It will be noted that a proviso is included in the proposed language which would make it unnecessary to appraise each bird individually as is done when animals other than poultry are involved. It is believed that the Bureau would not be warranted in going to the expense of appraising each bird individually. Therefore, the proviso has been added so that whenever, for example, the basis for appraisal for all birds of a group is the meat value, the group may be appraised as a unit. Groups of birds being appraised on the basis of their value as egg producers or as breeders similarly may be appraised as units. In this connection, the estimate for the appropriation "Diseases of Animals" contains an increase of $30,000 in the fiscal year 1947 which would be used to erect at the Agricultural Research Center a properly equipped building in which to conduct research on Newcastle disease.

(j) Special Research Fund, Department of Agriculture
(Allotment to Bureau of Animal Industry)

This budget schedule covers obligations under an allotment for special research projects and four regional research laboratories located at Auburn, Alabama, for study of the mechanism of infection in the contagious, infectious and parasitic diseases of livestock and poultry; Dubois, Idaho, for the improvement of sheep for Western ranges through the application of breeding methods; Ames, Iowa, for the improvement of swine through the application of breeding methods; and East Lansing, Michigan, for the improvement of viability in poultry. The following are the obligations under the allotment:

	1945	1946 Estimate	1947 Estimate
Estimated obligations	$336,230	$337,951	$335,508

PASSENGER-CARRYING VEHICLES

The amount requested for the fiscal year 1947 ($164,100) will permit the Bureau to replace 160 old vehicles at an average net cost of $750, and to purchase 42 additional cars in connection with the proposed increase under the item "Eradicating tuberculosis and Bang's disease." The number of cars to be replaced is about 25 percent of the Bureau's cars now in use. Of the 630 Bureau passenger-carrying vehicles now in operation, nearly 95 percent are used in inspectional work on farms in rural districts, and many of them have mileage of 18,000 and upward a year. It has been the Bureau's experience that cars assigned to rural inspectional work receive such rough use on secondary and country roads and lanes leading to farms that they normally would be replaced about every three years in order to keep mileage charges at the lowest possible point and to prevent frequent interruptions to the work which occur due to breakdowns when badly worn equipment is kept in service. However, under conditions which have existed for several years it has been imperative to use cars as long as possible, even though an earlier replacement would have been more economical. Every means possible has been used to extend the life of all cars. All the cars to be replaced have reached the point where they can no longer be kept in service, the average mileage being approximately 75,000 and in individual cases running as high as 125,000 to 150,000.

The Bureau is unable to carry on economically and efficiently its varied activities in the field by the use of public transportation. Therefore, when Government-owned cars are not available, it is necessary to authorize employees to operate their privately owned cars on a mileage basis. The Bureau has found that in normal times the use of Government-owned passenger-carrying vehicles for transporting its employees is considerably less expensive than when reimbursement is made to employees for the use of their own cars, and that they can be operated in almost every section of the country for slightly over three cents a mile. This estimate is based on purchase price and operation charges, less amounts received when old cars are disposed of. Even under the abnormal conditions which have existed for some time our mileage costs have been less than costs for use of the privately owned cars of employees.

PENALTY MAIL ESTIMATE
Sec. 2, Public Law 364, 78th Congress
(Allotment to Bureau of Animal Industry)

	1945	1946	1947	Increase (+) or Decrease (-) 1947 over 1946
Category 1	$288	$200	$200	- -
Category 2	20,252	18,000	20,000	+$2,000
Total	20,540	18,200	20,200	+2,000

Category 1 consists of bulletins and leaflets in connection with the work of the Bureau sent in reply to specific inquiries for information, and for mailing new pulbications which may be issued on foot-and-mouth disease, Bang's disease, hog cholera control, etc., to field employees and to individuals cooperating with the Bureau.

Category 2 consists of general administrative correspondence between Washington and the field stations located throughout the 48 States and the mailing of vouchers, payrolls, and other operating documents, etc. Also included in this category are cards and letters from field stations to farmers asking them to have their cattle ready for testing and announcing results of tests.

The increase of $2,000 for 1947 is based on an estimated increase in the mailing of administrative material in connection with the recommended increase of $506,000 included in the Budget estimates to cover additional operating expenses and indemnity payments incident to overdue retests of cattle under the item "Eradicating Tuberculosis and Bang's Disease." There will also be an increase in the number of cards and letters from field stations to farmers asking them to have their cattle ready for testing and announcing results of tests.

BUREAU OF DAIRY INDUSTRY

(a) Salaries and Expenses

Appropriation Act, 1946		$742,300
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+99,800
Total anticipated available, 1946		842,100
Budget estimate, 1947		1,011,000
Change for 1947:		
Overtime decrease	-14,400	
Increase	+183,300	
		+168,900

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Investigations of influence of breeding, feeding and management practices on efficiency of production	$315,301	$358,200	$404,012	+$45,812 (1)
2. Investigations of the nutritional and other physiological factors affecting the usefulness of dairy cattle	132,300	149,000	149,000	- -
3. Investigations of dairy herd improvement association practices in relation to efficiency of production	122,500	142,400	279,888	+137,488 (2)
4. Investigations of milk and milk products	145,000	171,900	171,900	- -
5. Administration and enforcement of the Process (or Renovated) Butter Act (regulatory)	5,400	6,200	6,200	- -
6. Overtime pay	87,890	14,400	- -	-14,400
Covered into Treasury as miscellaneous receipts, Public Law 529	30	- -	- -	- -
Unobligated balance	4,147	- -	- -	- -
Total available	812,568	842,100	1,011,000	+168,900
Transferred to "Salaries and expenses, Office of Information, Department of Agriculture"	+390	- -	- -	
Anticipated supplemental	- -	-99,800	- -	
Total estimate or appropriation	812,958	742,300	1,011,000	

INCREASES OR DECREASES

The net increase of $168,900 in this item for 1947 consists of the $14,400 decrease for overtime, and the following:

(1) An increase of $45,812 under the project "Investigations of influence of breeding, feeding and management practices on efficiency of production," composed of:

(a) An increase of $8,700 for further research in evaluating mammary gland development with the aim of effecting economies in dairy farming by identifying potentially low producing animals and eliminating them from dairy herds at an early age.

Between 5 and 6 million heifers must be raised each year to provide the replacements necessary to maintain the existing cow population. It can be assumed that about one-third, or 2 million, of these replacement heifers will prove to be unprofitable producers. The economic importance of being able to eliminate the potentially low producers as young calves is obvious when it is considered that the cost of raising each animal to producing age is at least $100.

Data have been obtained on heifer calves in the breeding herd of the Bureau of Dairy Industry to determine the significance of advanced and of retarded mammary gland development at a given age as an indication of potential producing capacity. A preliminary analysis of such data indicates that calves of retarded mammary gland development produced an average of from 2,500 to 4,000 pounds less milk than the calves that were advanced in mammary gland development at the same age. Grades assigned to evaluate degree of mammary gland development when the calf was approximately 4 months of age were found to be more indicative of potential producing ability than were those assigned at other ages. The herd at Beltsville, Md., where the data were obtained, has been bred up to a very high and uniform level of production. It is important that the results obtained at Beltsville be given a rigid test by obtaining similar data in many other herds where the inheritance for milk production is at a lower level and where the variability in producing ability is greater.

Data on the relative development of the mammary glands will be obtained on a large number of four-month-old heifers in herds representing different breeds, different levels of production, and different conditions of management. It is expected that these data will provide the final proof of the accuracy of judging the potential milk producing capacity of dairy heifers by evaluating the relative degree of development of the mammary gland tissue. Calves will not be culled on account of retarded mammary development during the course of the investigation or before they have demonstrated their producing capacity.

(b) An increase of $8,800 to analyze experimental data to determine the rate at which improvement in certain characteristics of dairy cattle is being accomplished.

Breeding experiments with dairy cattle progress very slowly because of the slow rate of reproduction and the time required for cattle to reach breeding age. Consequently, many years of experimentation are required before it is possible to show conclusive results or even trends. It is quite impossible to predict how many generations of proved sire matings would be required to produce lines that would approach purity for high levels of production. Under the most favorable conditions ten or more generations would probably be necessary to approach a fairly high degree of purity. In some of the experimental herds of the Bureau this objective has been approached in as few as five generations, depending on the degree of purity of the foundation animals. The Bureau has accumulated a large amount of experimental data over 25 years of research and it is possible that a complete analysis of these data would establish the apparent rate at which purity for high levels of production is being attained. An analysis of some of the data along this line recently made disclosed that in 15 privately-owned herds cooperating with the Bureau in its breeding program over a period of years, there were 265 foundation cows whose best production averaged 411 pounds of butterfat. The same number of first-generation daughters by Bureau-bred bulls averaged 461 pounds of butterfat; 171 second-generation daughters carrying two crosses of Bureau-bred bulls averaged 486 pounds; 67 third-generation daughters carrying three crosses averaged 541 pounds, and 26 fourth-generation daughters carrying four crosses averaged 559 pounds. Similar analyses of other cooperating herds should be made. Analyses should also be made to determine methods of inheritance and the rate of improvement for such characteristics as percentage of butterfat, persistency of production, size of animals, mortality of calves, constitutional vigor of cows, and peculiarities of conformation, in order that dairymen generally will be in possession of information based on scientific research which will enable them to adopt breeding programs for the improvement of their herds.

(c) An increase of $10,000 for further rebuilding the experimental herds at regional dairy experiment stations:

Objective: To assist in more effectively demonstrating dairy practices in regions where dairy experiment stations are established and to improve the producing ability of the dairy herds in such regions.

The Problem and its Significance: The Bureau is now operating eight regional experiment stations. These regions have problems or conditions that are more or less peculiar to large areas. Consequently, the work at the regional stations is directed toward problems of feeding and management, the solution of which will best help the dairy farmer to successfully conduct his business. The utilization of pastures and forage crops that are particularly adapted to the regional soil and climatic conditions is one of the most important fields of work. A part of the information obtained at these stations is primarily of importance to the regions served, but much of it

is also applicable to the dairy industry over larger areas. The work of all of the stations includes a breeding project in which an effort is being made to develop strains of dairy cattle that will be pure in their inheritance for high levels of milk production. Young bulls bred in these experimental herds are loaned for service in farm herds, or in some instances, when the requirements for loans cannot be met, are sold outright to dairymen. By these methods the producing efficiency of the farm herds is gradually being improved. During recent years the effectiveness of the work of these stations has been impaired because of the necessity for reducing the size of the dairy herds, such reductions being required by increases in labor and feed costs. For example, there are now only 27 females of breeding age in the Woodward, Oklahoma herd where formerly there were 39. The Huntley, Montana herd has been reduced from 64 to 47, and reductions in the Mandan, North Dakota; Lewisburg, Tennessee; Jeanerette, Louisiana, and Pontiac, South Carolina herds have amounted to 26, 19, 21, and 13, respectively. The small number of animals slows up the breeding work since it takes so much longer to complete a proved sire generation. These rather drastic reductions have thus reduced the number of bull calves available to farmers and, consequently, the herd improvement work is being seriously retarded in the regions served by the stations. In some of the herds difficulty has been experienced in obtaining balanced groups of animals for feeding experiments because of the small number of animals from which to choose.

(d) An increase of $18,312 to provide personnel essential to the maintenance of experimental herds at the Agricultural Research Center.

On July 1, 1943, there were 32 employees engaged in milking, feeding, and caring for dairy animals and in handling and processing milk at the Agricultural Research Center, Beltsville, Md. Because of military furloughs, resignations, and transfers, the number steadily decreased until on July 1, 1945, there were only 13 regular employees so engaged. Since January 1944 these activities have been conducted largely through the use of conscientious objectors. Twenty-one conscientious objectors are now performing dairy barn and milk plant work, for which the Bureau is required to pay $1,020 per annum per man. It is anticipated that most, if not all, of the conscientious objectors assigned to this project will be discharged by July 1, 1946. When the Bureau's personnel engaged in dairy barn and milk plant operations was at its maximum, the basic work week consisted of five 8-hour days and one 4-hour day, or a total of 44 hours per week. Thirty-two employees were engaged and performed 1,408 hours of work per week. Under existing conditions, that is, under a 40-hour work week, 35 employees will be required for an equivalent number of hours of work. Because of the shorter work week and the fact that the Bureau's base appropriation was reduced in 1946 by $33,420 due to a previous absorption of overtime costs which were deleted from the 1946 estimates, the present appropriation is insufficient for the employment of the personnel required to milk, feed, and otherwise care for the dairy herds. It is estimated

that 22 additional employees (2 CPC-5, 17 CPC-4, and 3 SP-4) will be necessary to replace the conscientious objectors. Under existing Pay Act scales, the minimum salaries of these grades are $948, $750, and $882, respectively, in excess of what is now being paid annually to each conscientious objector who would be replaced.

(2) An increase of $137,488 under the project "Investigations of dairy herd improvement association practices in relation to efficiency of production," to meet an accumulated and increasing proved sire and herd analysis tabulation work load.

Objective: To obtain data on individual cows and sires in dairy herd improvement association herds in order to evaluate the genetic worth of the animals and to disseminate the superior hereditary influence being developed in association herds to dairy herds generally, to the end that all dairy cattle of the Nation eventually will produce at a more efficient and profitable level.

The Problem and its Significance: There are approximately 26,000,000 cows in the United States kept for milking purposes. These cows have an average production of approximately 182 pounds of butterfat per year. This production is much too low in most cases to meet feed and overhead costs. The problem, therefore, is to raise production to the point where it will not only pay for feed and overhead but will also return a profit. That this is possible is demonstrated by the fact that the half million cows on test in dairy herd improvement associations have an average butterfat production of 338 pounds per year and return approximately $146 above feed cost. The producing efficiency of association herds has been developed over a period of years. On the average, production of association cows has been improved at the rate of approximately 30 pounds of butterfat per cow each decade. It is estimated that this increased producing efficiency is resulting at the present time in a total additional income to association members of more than $12,000,000 a year.

The following statement shows the extent of the dairy herd improvement association program from 1934 to the present time, and an estimation of the increase in the program which it is anticipated will occur to and including the fiscal year 1949.

(Continued on next page)

Year	Number of associations	Number of herds	Number of cows on test
1934	793	13,694	325,837
1935	809	15,573	364,218
1936	876	17,344	404,412
1937	992	20,772	496,562
1938	1,106	23,701	558,993
1939	1,228	25,949	625,284
1940	1,300	27,948	676,141
1941	1,383	31,381	763,502
1942	1,421	32,957	816,117
1943	1,057	24,155	616,972
1944	954	20,825	561,587
1945	949	21,254	577,200
1946	1,000 (est.)	23,000 (est.)	650,000 (est.)
1947	1,300 (est.)	30,000 (est.)	800,000 (est.)
1948	1,500 (est.)	35,000 (est.)	900,000 (est.)
1949	1,700 (est.)	40,000 (est.)	1,000,000 (est.)

The decrease in the number of associations in operation and in the number of cows on test in recent years was due entirely to the manpower situation. In other words, the States have been unable to employ the personnel required to operate a larger number of associations. Reports from the States indicate that more dairymen than ever before will place their herds on test as soon as personnel becomes available to supervise the work of new associations.

Even though the States have had great difficulty in maintaining field personnel to conduct the work of the associations, more data were reported to the Bureau than it could properly handle with the existing staff. Through the operation of the dairy herd improvement association proved sire program there has been accumulated the largest volume of production data on dairy cattle that exists in the world today. Most of these data, however, have not been compiled and made available to the dairymen of the Nation. At no time since the program started have sufficient funds been available to provide the personnel required to handle effectively the clerical work involved.

At present the herd analysis tabulation work is approximately 4 years in arrears. The recording of data received from the associations is now nearly 12 months in arrears. Sufficient data have been accumulated to prove at least 4,000 or 5,000 sires if adequate personnel for processing the data were available.

Plan of Work: Production and breeding records of cows in dairy herd improvement associations are reported by association supervisors through the various State agricultural colleges to the Bureau of Dairy Industry. These data are analyzed to determine the breeding worth of individual animals and families of animals. The data are then made available to State extension workers, dairymen, and dairy leaders for use in developing and conducting a constructive dairy cattle improvement program.

CHANGE IN LANGUAGE

The estimates include a proposed change in the language of this item as follows (new language underscored, deleted matter enclosed with brackets):

> Salaries and expenses: For necessary expenses, including not to exceed [$332,325] $520,320 for personal services in the District of Columbia, of the Bureau of Dairy Industry in carrying out the provisions of the Act of May 29, 1924 (7 U.S.C. 401-404), including investigations, experiments, and demonstrations in dairy industry, [cooperative investigations of the dairy industry in the various States,] for carrying out the applicable provisions of the Acts of May 9, 1902 (26 U.S.C. 2325, 2326 (c), 2327 (b)), and August 10, 1912 (26 U.S.C. 2327 (c)), relating to process or renovated butter, and the Act of May 23, 1908 (21 U.S.C. 94 (a)) insofar as it relates to the exportation of process or renovated butter, [$742,300] $1,011,000.

The proposed change in language deletes the words "cooperative investigations of the dairy industry in the various States," for the sole purpose of shortening and simplifying the wording of the item. The clause proposed for deletion is considered surplusage and, therefore, need not be retained in the annual appropriation act, the cooperative work being authorized by the Act of May 15, 1862 (5 U.S.C. 511), establishing the Department of Agriculture, which was implemented by the Act of July 24, 1919 (5 U.S.C. 563-564). Elimination of the language from the annual appropriation act will not--in any way--change the scope or character of the work performed under this appropriation item, or the authority of the Department to cooperate with other agencies, institutions, organizations, or others in the conduct of such work.

(Continued on next page)

WORK UNDER THIS APPROPRIATION

Objective: (1) To increase the milk and butterfat producing efficiency of the Nation's dairy cows; (2) to determine the nutritional value of milk, and the effect of the nutrition of the cow upon the milk produced, the nutritional requirements of calves, cows, and bulls to maintain optimum levels of usefulness, the value of feeds, feed constituents, and feeding regimes as sources of nutrients, and the physiological factors affecting the general economic usefulness of dairy cattle; (3) to improve the quality of products made from milk; (4) to effect greater efficiency in manufacturing methods, and to develop new milk products and provide for the more efficient utilization of milk byproducts.

The Problem and its Significance: There are about 26 million cows in the United States kept for milking purposes, the average butterfat production of which is about 184 pounds a year. This production is too low for profit. Only one-third of these cows actually return a profit to their owners. Methods of selecting and breeding should be devised so that at least 90 percent of the animals raised for dairy purposes will possess an inheritance for profitable production.

The national dairy herd must be fed in a manner that will maintain the health of the animals and insure the economical production of milk having maximum nutritive and health-giving properties. Research is required to determine the most efficient and economical methods of feeding for milk production, the relation of the cow's diet to her health and reproductive functions, and to the nutritive properties of the milk produced.

Quality control in the manufacture of dairy products is possible only through a knowledge of the bacteriological and chemical changes involved and of the application of this knowledge to factory practices. The basis for formulas applicable to factory conditions is obtainable only through research. Defects in quality are usually the result of insufficient information concerning the factors influencing quality and of the methods for controlling these factors under commercial conditions.

General Plan: The work is carried on through field and laboratory experiments in cooperation with state colleges, agricultural experiment stations, and extension services, other Government agencies, dairymen, and manufacturers of dairy products. Some phases of the work are conducted cooperatively in every state and in Hawaii and Puerto Rico.

Breeding experiments are conducted to ascertain the comparative effects of different methods of breeding in an attempt to fix an inheritance for high and uniform levels of producing ability in dairy cows; to develop methods for judging the potential producing ability of heifers at an early age in order to avoid raising to maturity those heifer calves that should be discarded at an early age because of their inferior potential milk-producing ability, and the effect of breeding and feeding practices on the level and economy of milk and butterfat production. Research in animal nutrition and physiology includes investigations to determine the nutritional value of milk and the effect of the nutrition of the cow upon the milk produced; the energy, protein, minerals, vitamins, and other nutritional requirements for calves, cows, and bulls to maintain optimum levels of usefulness; the value of various feeds, feed constituents, and feeding regimes as sources of nutrients, and the physiological factors affecting the general economic usefulness of dairy cattle.

Research is also conducted to discover the basic faults in the production of market milk and to devise remedies which can be readily and economically applied; and to increase the returns to the producers of milk by increasing consumption through improvements in the quality of manufactured milk products, by lowering the cost of manufacture through increased efficiency and reduction in the proportion of undergrade products, and by converting byproducts of milk into marketable form.

(Continued on next page)

Examples of Progress and Current Program: The following are examples of recent accomplishments under this appropriation.

Investigations of the influence of breeding, feeding and management practices on efficiency of production:

Proved bulls in cooperating herds. The following tabulation shows the number of bulls from the experimental herds at the Beltsville station in service in herds of cooperators:

	Holstein	Jersey	Red Danish
In artificial breeding associations	19	7	-
In State institution herds	14	-	-
In cooperative bull associations	25	13	-
In privately-owned herds	24	21	-
In 3 county organizations of cooperative farmers in Michigan	-	-	23

Data on the number of cows bred to these bulls are not complete.

One proved Holstein bull loaned to the New York State Breeders' Cooperativ in 1941 was in service for artificial insemination until June 1944, and during that period sired some 3,000 calves.

One hundred forty-seven bulls from experimental herds at other dairy experiment stations are in service in institution and privately-owned herds. Four are in service in artificial breeding associations.

Proved bulls increase production in farm herds. At the Jeanerette, La., station 17 Jersey sires have been proved in cooperators' herds. These sires had 297 daughters, the average production of which was 328 pounds of butterfat (mature equivalent basis), or 32 pounds more butterfat than the dams produced under similar conditions. Thirteen, or 77 percent, of the bulls sired daughters that excelled the production of their dams on the average.

At the Woodward, Okla., station 25 Holstein bulls have been proved in cooperators' herds, with a total of 282 tested daughters. These daughters on the average, produced 388 pounds of butterfat as compared to an average production of 343 pounds for the dams, or an average increase of 45 pounds Twenty-four of the bulls, or 96 percent, sired daughters that averaged higher in butterfat production than their dams.

Some three years ago a bull bred at the Huntley station was loaned to the University of Hawaii. A recent report from the University shows that this bull is the sire of some 30 bull calves and some 23 heifer calves in the University herd and that 9 of these bull calves are now in service in commercial herds on the Islands. Thus, the superior germ plasm developed in the Huntley herd is being used for the improvement of Hawaiian dairy herds.

Fixing inheritance for high levels of production by the use of proved sires. The following tables show the number of Holstein and Jersey cows in the Beltsville, Md., and Woodward, Okla., herds that have made records under the standard environmental conditions prescribed for use in interpreting their inheritance for level of production, grouped according to the number of meritorious proved sire crosses in their immediate ancestry. That is, the cows in the group for 1 proved sire cross are daughters by proved sires; the cows in the group for 2 proved sire crosses are daughters by proved sires, as are their dams; the cows in the 3 proved sire group are by proved sires, as are their dams and their maternal granddams; those in the group of 4 proved sire crosses are by proved sires, as are their dams, their maternal granddams, and their maternal great-granddams. Thus, cows in the 1 proved sire cross group have received 50 percent of their inheritance from a proved sire; cows in the group for 2 proved sire crosses have received 75 percent of their inheritance from proved sires; while cows in the groups for 3, 4, and 5 proved sire crosses have received 87.5, 93.75, and 96.87 percent, respectively, of their inheritance from proved sires.

If the sires selected because of their inheritance for high levels of production were actually homozygous for the hereditary factors determining high levels of production, the cows in the 5 proved sire group would be approaching the pure line status for high levels of production, but it is very difficult to find sires that actually possess an inheritance approaching homozygosity for the factors determining high levels of production and the extent to which one of them may be heterozygous delays the approach of a group to homozygosity.

Beltsville, Md.

Number of proved sire crosses	Holsteins: Number of cows	Holsteins: Average butterfat production*	Jerseys: Number of cows	Jerseys: Average butterfat production*
		Pounds		Pounds
1	33	663	47	658
2	31	705	35	739
3	44	768	35	761
4	44	837	23	796
5	16	848	--	---

Woodward, Okla.

Number of proved sire crosses	Number of cows	Average milk yield*	Average butterfat	Average butterfat yield*
		Pounds	Percent	Pounds
1	30	20,670	3.27	676
2	30	17,972	3.53	634
3	18	19,075	3.66	699
4	11	18,950	3.90	738
5	4	17,986	3.94	709

* Mature equivalent.

Most of the cows in the 2 proved sire cross group in the latter table were by a sire whose daughters had considerable udder trouble while making their records, and this probably accounts to some extent for the fall in production of that group.

The data for both the Beltsville and Woodward groups, as well as for cows in the Huntley, Mont., herd, reported last year, show a rather uniform tendency for higher levels of production for each additional proved sire generation. It also effectively explodes one theory that has long dominated the practices of dairy cattle breeders, i.e., the necessity for using sires within a family or strain in order to obtain good results. The sires used in this work were selected on the basis of their inheritance for level of production without regard to their relationship; in fact, an attempt has been made to select unrelated sires in the Holsteins used at Beltsville.

Proved bulls maintained high level of production in inbred cows. The second bull used in the line breeding experiment, Pride Ormsby Gerben Colantha Ona, has proved that he possesses quite a remarkable germ plasm for high levels of production. His sire is Pride of the Bess Burkes, the third proved sire used at Beltsville, and his dam was a daughter of Varsity Derby Matador, the second proved sire used, and she in turn was out of a daughter of Denton Colantha Sir Rag Apple, the first proved sire used. Thus, Pride Ormsby Gerben Colantha Ona is the product of three generations of outbreeding in the Beltsville herd. He has been used in the Beltsville station herd mostly on cows that were sisters to his dam. Twenty-five of his daughters of this line of breeding have completed records, and their average yield (mature basis) and the average yields of their dams is:

	Milk (Pounds)	Butterfat (Percent)	Butterfat (Pounds)
25 daughters	20,528	3.89	794
25 dams	18,569	3.80	706

Four of his daughters have now completed records of over 1,000 pounds butterfat in a 365-day lactation period. One daughter, Line-Gerben Colantha Piebe, produced 32,192 pounds of milk testing 3.75 percent and containing 1,207 pounds of butterfat. This is the highest butterfat record made by a Holstein cow in the United States when milked 3 times a day. Another daughter, Line-Gerben Colantha Watson, produced 25,403 pounds milk testing 4.34 percent and containing 1,103 pounds of butterfat. She was bred back to her sire to produce the cow Miss Ormsby Line-Colan-Gerb Pride who made a record of 24,822 pounds of milk testing 4.15 percent and containing 1,030 pounds of butterfat.

An interesting and unusual demonstration of transmitting ability for high levels of production by Pride Ormsby Gerben Colantha Ona is shown in the following tabulation of the production records of 4 of his inbred daughters, the production records of their dams, which are also his daughters, and the production records of the granddams, all daughters of Varsity Derby Matador out of daughters of Denton Colantha Sir Rag Apple.

Inbred daughters				Line-bred daughters				Granddams of inbred daughters			
No. of cow	Milk	Fat	Fat	No. of cow	Milk	Fat	Fat	No. of cow	Milk	Fat	Fat
	Pounds	%	Pounds		Pounds	%	Pounds		Pounds	%	Pounds
1249	17,758	4.15	737	895	16,717	3.79	634	817	10,529	3.34	353
1289	20,317	3.60	732	1247	24,595	3.43	844	850	15,474	3.41	528
1298	24,822	4.15	1,030	1215	25,403	4.34	1,103	832	23,319	3.36	783
1627	20,615	3.95	814	1244	20,002	3.94	789	812	20,603	3.78	779
Average	20,878	3.96	828		21,679	3.88	843		17,481	3.47	611

It is not uncommon to find the production level depressed by close inbreeding, but these 4 inbred daughters of Pride Ormsby Gerben Colantha Ona have maintained a remarkably high level of production. The average is slightly lower than that of their dams, but 2 of the 4 inbred daughters have higher levels of production than their dams. It is evident that this sire possesses an inheritance for a high percent butterfat. Of the 8 daughters shown in this tabulation all but one show a higher percent butterfat than their dams. Also, the increase made by the line-bred daughters in percent butterfat is unusually high.

The granddam No. 817 is a much lower producer than the other cows in this tabulation. For some unknown reason she failed to grow and her production level was also low.

Increased appropriations provided for this work for 1946 enables the Bureau to keep more breeding animals, and thus accelerate the number of proved sire generations that can be produced in a given period. At least 40 daughters in each proved sire generation are desirable. At times, several years have been required to produce this number of daughters by a given sire. With larger numbers of females to breed it is hoped that 40 females may be produced in a period of 2 years; thus, a new proved sire could be brought in every second year and the time for producing an additional 5 generations reduced 50 percent.

Bulls from station herds will continue to be placed in herds of cooperators to prove their inherent ability for transmitting high and uniform levels of milk and butterfat production.

The mating of related sires to unrelated cows will be continued to obtain line-bred heifers that are to be compared with outbred heifers.

The 4 proved sires in the Jersey outbreeding-inbreeding experiments will continue to be mated with their own daughters to secure the necessary inbred daughters. The progress of the project has been delayed because of the mortality among inbred heifers. It is planned to give inbred heifers special care and feeding in an attempt to reduce the mortality.

Pastures are profitable if properly managed. Three years' results have been obtained in a cooperative experiment to ascertain the carrying capacity of irrigated pastures in the mountain regions that were rotationally grazed, manured, treated each year with phosphate and mowed to control weeds.

The results are summarized as follows:

	1942	1943	1944
Length of grazing season (days) . . .	179	174	189
Standard cow days per acre	253	246	261
Milk production per acre (pounds) . .	8,376	8,234	9,501
Pounds of milk (corrected to 4% fat).	7,530	7,737	8,829
Alfalfa hay replacement from pasture (tons)	4,016	3,905	4,153
Gross pasture value (based on butterfat @ 90¢ per pound. Cost of supplementary feed deducted). . . .	$213.36	$220.13	$249.31

It will be noted that the pasture showed greatest value in the third year, and that irrigated pastures in the mountain area are very profitable to dairymen if properly managed and fertilized.

Grazing crops as sources of nutrients at Willard, N.C., station. The yields of winter grazing crops seeded in the fall of 1943 were seriously depressed by drought and by attacks of aphis on the growing cereal crops. The damage to the grains on some plots was as high as 90 percent and was estimated to average 70 percent on all plots. Crops that were seeded earliest were the most severely damaged. Fortunately, the legumes seeded with the grains on some of the plots were not attacked by the aphis and these legumes furnished the bulk of the grazing obtained. The crops that gave the most grazing per acre were: (1) two plots of oats, barley, and crimson clover, 75.2 and 64.0 standard cow days; (2) Italian rye grass and crimson clover, 54.9 days; (3) wheat (seeded in November), 38.8 days; and (4) oats, barley, and vetch, 38.2 days.

The oats, barley, and crimson clover crop combination yielded the greatest amount of total digestible nutrients per acre. On the basis of the amount of hay that would contain an equivalent amount of total digestible nutrients to that produced by any given crop combination, the crop combinations that had the lowest cost of production in terms of the cost of producing a ton of alfalfa hay were: (1) oats, barley, and crimson clover (seeded 9-8-43), $13.46; (2) Italian rye grass and crimson clover, $13.62; (3) oats, barley, and crimson clover (seeded 8-17-43), $15.36; (4) wheat (seeded 11-3-43), $18.00; (5) oats, barley, and vetch (seeded 9-1-43), $26.12. Oats and barley seeded 8-23-43 had an equivalent cost of $72.81.

The winter annuals provided grazing from October 21 to November 24, and from March 6 to May 17, a total period of about 3.5 months. The summer annual grazing plots were affected by low rainfall conditions that prevailed from the middle of April through the middle of June. There was a well distributed rainfall during the remainder of the season that resulted in some of the best grazing the summer annuals have furnished during the course of the experiment.

The standard cow grazing days varied from 70 to 76 days for 6 of the 7 crop combinations. Kudzu, with 53.5 standard cow grazing days, had the shortest period. The yields of total digestible nutrients per acre in the order of the greatest to the smallest were: (1) Ogden soybeans, 1,230 pounds; (2) Korean and Kobe lespedeza and Pearl millet, 1,222.6 pounds; (3) Pearl millet and Sudan grass, 1,210 pounds; (4) Ogden soybeans, 1,205.8 pounds; (5) Korean and Kobe lespedeza, 1,145.5 pounds; (6) Tift Sudan grass, 1,125.9 pounds; and (7) Kudzu (a perennial), 793.6 pounds. The costs of production in terms of alfalfa hay per ton equivalent were: (1) Korean and Kobe lespedeza, $7.12; (2) Tift Sudan grass, $9.44; (3) Korean and Kobe lespedeza and Pearl millet, $9.62; (4) Pearl millet and Sudan grass, $10.26; (5) Kudzu (perennial), $10.30; (6) Ogden soybeans, $11.42; and (7) Ogden soybeans, $11.64.

Grazing on these crops was from June 29 to October 4,--a little more than 3 months; thus, the period over which both the winter and the summer annuals were grazed was less than 7 months. A permanent pasture of carpet grass, with some legumes--notably hop clover in the early spring--provided grazing from April 25 to November 25, a period of 7 months.

Pasture grasses as sources of nutrients. In an effort to find out the best combinations of grasses and clovers and the best management practices for the region in which the Lewisburg, Tenn., station is located, a series of 12 experimental pasture plots were seeded in 1942 to various combinations of grasses and clovers, including lespedeza, Dutch white, hop, crimson, and ladino clovers, orchard grass, and bluegrass. Most seedings were made on prepared seed beds but on some plots the seed was sown on the sod.

One plot seeded to orchard grass and ladino clover and limed and manured furnished nutrients for cows to produce at the rate of 5,996 pounds of milk and 244 pounds of butterfat per acre. It furnished grazing at the rate of 166 cow days per acre. In addition to the grazing the cows consumed a simple grain mixture at the rate of 964 pounds per acre. Deducting $24 for the cost of the grain and an estimated $5 for the cost of mowing weeds and for lime and manure, the net value of the milk produced was $142 per acre.

Included in the series were two plots of bluegrass sod which received no fertilizer treatment. One plot was mowed twice each season to control weeds; the other plot was not mowed. Both plots were grazed by milking cows. The plot that was mowed gave a net return of $56 per acre in terms of milk produced, which was $10 more than the return from the plot that was not mowed. The cost of mowing amounted to $1.74 per acre. Hence, a return of $10 was received from an expenditure of $1.74. Mowing controlled the weeds and brush that the cattle did not graze, and increased the growth and spread of desirable grasses.

Effect on lactation of feeding concentrates at different rates. An experiment at the Mandan, N.Dak., Huntley, Mont., and Woodward, Okla., stations was begun in 1943 to determine if a heavier rate of grain feeding during the period of greatest milk production would result in greater production for the entire lactation than when the rate of grain fed in proportion to milk production was uniform throughout the lactation. Two balanced groups of cows at each station were fed as follows: Cows in Group 1 received alfalfa hay and silage ad libitum and were fed grain at the rate of 1 pound to each 6 pounds of milk produced throughout the 300-day lactation period. Cows in

Group 2 were fed the same except that they received grain at the rate of 1 pound for each 3 pounds of milk produced during the first 100 days of lactation; 1 pound of grain for each 6 pounds of milk produced during the second 100-day period; and no grain during the last 100 days of lactation. Cows were pastured at the Mandan station while on the experiment, but not at the other stations.

A preliminary analysis of the records of 22 cows in the experiment that completed 300-day lactation periods reveals that the group of cows fed grain at the rate of 1 pound for each 3 pounds of milk produced during the first 100 days of lactation produced an average of 478 pounds of butterfat as compared to 432 pounds for the cows fed grain at a uniform rate of 1 pound of grain for each 6 pounds of milk produced. This increase of 10 percent came largely during the first 100 days.

Relative carrying capacity of alfalfa and ladino clover at the Huntley, Mont. station. In 1940 alfalfa was seeded in 3 separate half-acre plots at the Huntley, Mont., station. One plot was seeded with canary grass, another with meadow foxtail, and the third with orchard grass. In another series of 3 half-acre plots, ladino clover was seeded with these same grasses. The object was to determine the relative carrying capacities for dairy cows of these different grasses in combination with alfalfa and with ladino. The alfalfa combinations produced during 1942, 1943, and 1944 an average of 4,954 pounds of total digestible nutrients per acre each year, as compared to an average of 4,828 pounds for the ladino combination. The alfalfa combinations gave greater yields in the first 2 years but produced less the third year. In the third year the alfalfa combination yielded 4,189 pounds of total digestible nutrients per acre, while the ladino clover combination yielded 4,854 pounds per acre. The yield from the latter is being maintained at a rather constant level, while the yield from the former is declining. The alfalfa is going out rapidly and will provide only a minor portion of the nutrients from now on.

The plots containing canary grass gave the highest yields over the 3-year period, followed by the orchard grass and meadow foxtail in the order named. Using the canary grass yield as 100 percent, the relative yields of the orchard grass and meadow foxtail with alfalfa were 95.1 and 85.8 percent, respectively, and with ladino clover they were 94.6 and 87.7 percent, respectively.

The yields of all of the grazed plots are considered highly satisfactory. On a comparative total digestible nutrient basis the alfalfa combination would represent a yield of 4.9 tons of alfalfa hay per acre and the ladino combinations would represent a yield of about 4.7 tons of alfalfa hay per acre

In 1944 the total digestible nutrient yield per acre for the ladino clover combinations was almost 16 percent greater than the total digestible nutrient yield for the alfalfa combinations. The milk and butterfat yields in 1944 on the ladino clover combinations also exceeded the yields on the alfalfa combinations by approximately 15 and 12 percent, respectively. Since the total digestible nutrient yield is calculated in part from the milk and butterfat yield there is likely to be a similarity in the relative total digestible nutrient yield and the milk and butterfat yield. Clippings from the

different plots indicated that the yield of dry hay on the ladino clover grass plots exceeded the yield of hay on the alfalfa grass plots by a little more than 8 percent.

The milk and butterfat yields were somewhat greater on the orchard grass plots of both series.

The pasture experiments and those involving comparisons of summer and winter grazing crops at the different experiment stations will be continued. The project on the effect of feeding concentrates at different rates during different parts of the lactation period should be completed during the year.

Use of sulfa drugs to control mastitis. The use of sulfa drugs for treating mastitis infections showed an average effectiveness of approximately 68 percent in treating four different types of infection. The udder infusions did not have any significant depressing effect on milk secretion, and there were no unfavorable reactions resulting from the treatment.

Following the use of these preparations another sulfonamide preparation containing urea was used. Fifty-three treatments with this preparation were administered. The results are not complete and final tabulations will not be possible until cows treated while dry have again freshened. For the entire period of these treatments, which goes back to August 1943, milk production averages for the 10 days immediately before and after treatment are available for 38 lactation periods. The decline in average daily milk production during the 14-day interim between the mid-points of these periods was from 32.90 to 30.95 pounds, or about 6 percent. This does not greatly exceed the expected average decline for the same period in untreated cows.

During the year penicillin was made available for use in a cooperative project with the Bureau of Animal Industry for studying its effectiveness in eliminating mastitis infections. Procedures for administering the treatments and for evaluating the results were worked out by a joint committee representing the two Bureaus. The known results showed that penicillin was effective to the extent of about 47 percent.

Method for determining the potential producing capacity. A preliminary analysis of data obtained in the Beltsville herd indicated that the degree of advancement of mammary gland development in the calf at 3 to 5 months was indicative of potential producing capacity. The average mature equivalent production of milk in the first lactation period was some 2,500 to 4,000 pounds greater for the cows that were graded high as calves than for those that were graded below average at the same age. These results were obtained from a study of animals in the Bureau's breeding herd at Beltsville, Md., where production is uniformly high. A greater degree of variation might be found in herds where uniformly high production does not prevail. The results are encouraging since they indicate that it may become possible to predict the relative producing capacity of dairy calves at 4 months of age; thus making it possible to identify and cull low producers at an early age. The present need is to test the method in herds having extreme variability in producing capacity to determine its reliability. The test involves grading the calves in a herd as they reach the age of 4 months, and after their production records have been completed, comparing statistically the relative degree of mammary development as calves, and their level of production.

Study of bovine fetus at various stages of gestation. Pregnancy is a disturbing factor in the interpretation of results in many studies pertaining to the growth, nutrition, physiology, body form, and anatomy of domestic animals. Studies have been made of (1) the size (weight) of the uterus and each of its contents at successive 30-day intervals up to full term; (2) measurements of the body proportions of the fetus at successive stages of gestation and in relation to corresponding body proportions in the cow; and (3) the changes in the relation of the weights of the fetus, the fluids and the fetal membranes, to the total weight of the gravid uterus. There is need for fundamental data as to the extent the live weight of the cow is represented by the weight of the uterus and its various contents at successive stages of gestation.

Are body proportions in the calf indicative of type in the cow? Substantial progress has been made in analyzing accumulated data on measurements of body form in growing heifers to ascertain the extent to which the size and shape of the body (type) of the calf can be used as a guide in predicting the size and body form of the cow. Predictability with regard to size in any measurement increases with a high degree of regularity with advance in age. That is, measurements taken at 12 months of age are a better indication of the ultimate corresponding measurements in the cow than are those taken at 3, 6, or 9 months of age. In both of the breeds studied (Holstein and Jersey) the measurements taken on young heifers that had the closest correlation with those taken during first lactation were the body heights and the length and width of the head. Body height and head dimensions taken at the early age of 6 months were more reliable indications of the corresponding measurements during first lactation than was the live weight taken at any age up to and including 18 months. Correlation studies are now in progress to determine the relation between body size and form as a calf and after she attains maturity.

Post-mortem studies of mammary structure. Over a period of years post-mortem data have been obtained on the size, capacity, and structure of the udders of approximately 625 cows and heifers in the Bureau's herd at Beltsville. Correlation studies based on random samples of udders taken from cows lactating at the time of death indicate that there are positive relationships between demonstrated producing capacity, as shown by production records, and such characteristics as empty weight of udder, capacity of udder, and the proportion (percentage) of gland tissue in the udder. In non-lactating udders positive relationships were largely absent or concealed by the influence of other factors. It is expected that progress will be made in analyzing all available data to determine the interrelations between udder characteristics and milk producing capacity, and the effects of breed, age, and stage of lactation at time of death upon various udder characteristics.

Circulatory system of the udder. In tests to throw further light on the significance of subcutaneous vessels on the surface of the udder, these vessels were tapped in a number of living cows and samples of the contents were drawn into a syringe. It was found that a majority of these subcutaneous vessels contained blood and are a part of the venous system but that lymph vessels also occur in similar areas on the udders of some cows.

The completion of analysis of data on changes in the size of the gravid uterus and of its various contents with advance in stage of gestation is contemplated during the current fiscal year. Other phases of the project which will receive attention are:

(a) Introducing and supervising field tests to determine the reliability of using the evaluation of the degree of mammary development in the calf as a means of identifying the potentially high or the potentially low producing individuals. Additional data also will be obtained in animals in the Bureau's herd at Beltsville.

(b) Continuation of the analysis of accumulated data on body measurements of growing heifers to determine to what extent body form in the calf can be used in predicting the body form and also the producing capacity of the cow; and

(c) Analysis of data obtained on some 600 udders to determine the significance of size and capacity of the udder, and of various characteristics of the structure and properties of the mammary tissue, in relation to the production performance of the cow.

(Continued on next page)

(Continued on next page)

Investigations of the nutritional and other physiological factors affecting the usefulness of dairy cattle:

Colostrum as a source of vitamin A. Calves are born with very little or no vitamin A stored in their bodies, and depend upon their mothers' colostrum for an immediate supply of this nutrient. Without an adequate supply they develop scours, may go blind, or die of scours or of symptoms resembling those of pneumonia. Colostrum has generally been considered an excellent source of vitamin A. Results of experimental work show that it is a variable source and that its potency depends upon the diet of the cow. For example, if the amount of colostrum frequently fed to a calf were produced by cows on pasture, the calf might receive about 137,000 International Units of vitamin A, but it would receive only 29,000 International Units if the colostrum were produced by cows on barn ration containing a poor quality of roughage. The vitamin A potency of the milk fed to calves following the colostrum feeding would likewise vary with the diet of the cows producing it. In the experiment referred to the cows on pasture subsequently produced a milk fat that contained 20,000 International Units of vitamin A per pound and the cows on the barn ration produced a milk fat containing less than 5,000 International Units per pound. This latter is insufficient to supply enough vitamin A for the optimum growth of the calf.

Similar studies are being made on other nutrients in colostrum.

Vitamin A potency of milk and butter. Work was conducted in cooperation with twenty State Agricultural Experiment Station laboratories to determine (1) the average vitamin A potency of the butter produced in the United States; (2) the effect of commercial methods of storage on the vitamin A potency of butter; and (3) the vitamin A potency of butter sold on retail markets. The results show that winter butter has a vitamin A potency of about 11,000 International Units per pound; that summer butter has an average vitamin A potency of 17,000 to 18,000 International Units per pound, and that the average potency of the annual output of all creameries is approximately 15,000 International Units per pound. About 64 percent of the creamery butter produced in the United States was found to have the potency of the summer product, and about 36 percent had the potency of winter butter. There is practically no loss of potency during the ordinary commercial storage and handling of butter. The butters sold on the retail markets have the same average potency as that sampled at the creameries. Butters containing as much as 23,000 International Units per pound were produced under very good pasture conditions.

The difference in vitamin A potency between winter and summer butter is due very largely to a difference in the amount of the precursor of vitamin A (carotene) in summer and winter feeds. Through proper feeding of the cows butter of the so-called summer potency could very well be produced in winter. Practical methods are now being developed for the guidance of dairymen in adopting feeding practices that will be economical and at the same time result in a higher vitamin A potency of the milk produced.

Better methods of producing feed for winter feeding. There are large losses in feeding value in the ordinary methods of making hay. During the past year

comparisons have been made of the feeding value of alfalfa preserved as silage and as field-cured hay. Work is now in progress to compare the feeding value of alfalfa preserved (1) as field-cured hay, (2) as hay partially dried in the field and then dried over a "mow" drier, and (3) preserved as silage. The efficiency and economy of such methods of preservation are being investigated. Previous work indicated a greater protein and carotene content of the alfalfa that was preserved as silage, as well as a greater vitamin A potency of the milk and butter produced by the cows to which it was fed, and a somewhat greater milk yield.

Pasture renovation through use of phosphate, tillage and seeding. Pastures will probably be an important factor in postwar dairying; consequently, the development of methods of establishing and renovating pastures is being given serious attention in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering. It has been shown that (a) application of phosphate fertilizer increased the yield of herbage; (b) drilling the fertilizer on undisturbed sod at a depth of three to four inches gave better results than surface application, while on the disced sod, surface applications gave better results than drilling; and (c) applying fertilizer by harrowing it in on the surface of the plowed sod proved better than applying it at the bottom of the furrow. A comparison of different kinds of phosphorus-carrying fertilizer showed no conclusive results.

The herbage from the plowed and disced plots was higher in protein, calcium and phosphorus than from the undisturbed plots, probably because of a higher legume content. Grazing tests failed to show any differences in palatability due to fertilizer treatment. The herbage appeared to be more closely grazed on the plowed plots than on the others, with the disced plots next in order.

Increased amounts of carotene do not increase milk yield. Production records for the first lactation period of cows in the nutrition herd fed rations containing different amounts of carotene or vitamin A showed that larger amounts of vitamin A and carotene improved the vitamin A potency of the milk produced and of butter made therefrom, but there was no evidence of a favorable effect on milk yield.

Effect of rations of different carotene and vitamin A content on conception. Records of the breeding performance of 91 cows that have been fed rations containing various amounts of carotene or vitamin A show that these cows have borne 219 calves excluding their first calves. The records do not show any reduction in the number of services per conception with the cows receiving rations containing the larger amounts of vitamin A. The number of services per conception was no lower for pasture-fed cows than for cows on barn rations which supplied only slightly more vitamin A than was required to produce calves that were normal at birth.

Effect of vitamin A on the reproductive performance of bulls. The reproductive functions are controlled by the very small gland known as the pituitary gland, which lies just beneath the brain. It is the anterior lobe

of this gland which dominates these functions. A vitamin A deficiency early in the life of the calf was found to produce an abnormal development (referred to as a cyst) in this gland. These cysts vary in size, and it was not known whether animals could subsequently recover from them or whether this condition would later in life interfere with the usefulness of the animal. It has been shown that bulls do not recover from these cysts; but, despite the persistence of cysts that are sometimes very large, bulls may still produce fertile semen. A vitamin A deficiency will produce testicular dogeneration in the bull, but this can be corrected by carotene or vitamin A therapy. Bulls will continue to produce fertile semen even if the amount of vitamin A fed is below that which will cause vitamin A deficiency as indicated by blindness. Semen produced by vitamin A-deficient bulls cannot, however, be classed as high in quality. It appears that before a bull becomes sterile as a result of a vitamin A deficiency, it must be maintained on a rather poor carotene ration, particularly if it has had ample vitamin A during the growing period. Vitamin A deficiency apparently causes a delayed sexual maturity, i.e., age when a bull starts producing semen. This delay may conform with the retardation in growth. More data are needed on this point and on the question as to the effect of vitamin A deficiencies on the capacity of the bull to function.

Unidentified growth-promoting factor in milk. Work previously reported on this problem has continued. The results to date indicate that a growth-promoting factor, X, which is not identical with any known nutrient and which has not been identified chemically, exists in milk and milk products, hays and leafy foods, beef and pork muscle, egg yolk, and liver extracts, but does not occur in white flour, enriched flour, whole wheat flour, wheat bran, linseed oil meal, soybean oil meal, egg white, and yeast. Efforts to vary the potency of milk as a source of this factor by varying the amount of the factor in the diet of the cow, have not been successful, but tests of preparations from different milks do suggest that milk may vary somewhat in potency. Thus, on an average, 5 milliliters of milk daily, which would contain about 0.45 gram of skim milk solids, increased growth by about 35 percent, whereas 4 percent skim milk powder made from different milk and supplying about 0.3 to 0.4 gram of skim milk solids, increased growth by about 50 percent. The milk and milk powder was added to a diet already containing adequate amounts of every known nutrient. Feeding additional milk or skim milk powder in these diets produced still better growth.

A further study of the growth of animals on diets containing adequate amounts of all known nutrients, but varying in protein content, showed very surprising results. When animals were fed diets containing 20 percent or 45 percent of protein without a supplement of X, they grew 147 and 77 grams, respectively, in 4 weeks--i.e., 47 percent less on the diet containing the greater amount of protein. Animals receiving 65 percent of protein in a diet unsupplemented by X failed to survive for more than 2 weeks. Sex-litter mates of the above animals fed a supplement containing X grew 276 and 254 grams on the 20 and 45 percent protein diets, and those on the 65 percent protein diet supplemented with X grew 235 grams. The protein used in these experiments was casein, the principal protein in milk, but egg white was

also fed at levels to supply 25 and 45 percent of protein. The egg-white protein diets gave exactly the same results as the casein-containing diets. It has not yet been determined whether a deficiency of X interferes with the digestion or the metabolism of protein. The above results and the fact, previously reported, that a deficiency of X in the diet produces hypertrophy of the kidneys, certainly indicates that X plays a very important role in connection with the utilization of protein.

Analyses of the carcasses of animals that were fed rations supplemented and not supplemented with X, throw additional light on the action of this unidentified nutrient. The large increases in growth due to feeding X were found to consist of body protein laid on and of the water that would naturally be associated with this protein in the protoplasm of the animal. Nevertheless, the largest percentage increase in any body constituent was the amount of fat. This is suggestive when it is considered that when an excessive amount of protein is fed, it may be converted into fat and stored as such. X evidently may play an important role both in the growth and fattening of animals.

The results of an additional phase of work on this problem should receive mention. It was previously reported that rats, fed diets adequate in all known nutrients, vary in the rate at which they mature and the extent of their development at maturity, depending upon whether they are or are not fed X. Vaginal patency, for instance, occurs in rats at 54 days of age when they do not receive a supplement of X, but at 35 days when they receive X in their diet; and at maturity the ovaries and uteri of the latter may be three and four times as heavy, respectively, as in the case of the animals not receiving X. A study of the growth of young rats, reared by mothers fed X-free rations and rations containing X, showed that the young reared by mothers receiving X grew faster not only while nursing, but subsequently when continued after weaning on a diet deficient in X. It has not yet been determined whether this result is brought about through an improvement in milk yield or in the quality of the milk produced by the rat. It certainly shows that these animals may store X in their bodies, and may store enough of it to affect their well-being for a large portion of their lives.

Vitamin dosing of young calves and loss of calves due to infectious scours. Results obtained elsewhere indicate that a mixture of certain vitamins (vitamin A, niacin and ascorbic acid), when fed to calves early in life, reduces calf losses due to scours. There has been considerable effort to exploit these observations commercially. There is no doubt that scours is one of the symptoms of a vitamin A deficiency in young calves, but there is also no doubt that infectious cases of scours occur even with calves on rations that supply adequate amounts of vitamin A and that these cases are the source of large losses to the farmer. According to results obtained by the Bureau the above mixture of vitamins has no effect on the incidence of these infectious cases of scours--i.e., on the incidence of the type of scours that does not result from a deficiency of vitamin A. With calves fed small amounts of sulfathiazole or sulfaguanidine, the results are very much more encouraging. Of 14 calves that have now been fed these drugs, not one has been lost as a result of scours. This work is continuing.

Methods of feeding calves that will conserve milk for human use. A comparison of results of feeding calves colostrum for 3 days and (1) skim milk immediately thereafter to 180 days of age, or (2) skim milk to 30, 60, or 90 days of age, with (3) the method frequently used in rearing calves by feeding colostrum, then whole milk for about 30 days, and skim milk thereafter to 180 days of age, shows that it is entirely feasible to raise Holstein heifer calves by methods 1 or 2, and weaning from the skim milk at either 60, 90, or 180 days of age; but Holstein male calves (steers) are on an average about 30 pounds (7 or 8 percent) underweight at 6 months of age, when reared according to method 2 and weaned from skim milk at 60 or 90 days of age. Jersey heifer calves grew as fast when reared according to method 2 and weaned at 90 days, as when reared according to method 1; but in both instances they were on an average about 30 pounds underweight at 6 months of age, and the performance of Jersey males (steers) reared according to method 2 was much like that of the Holstein males when similarly reared.

In the above experiments grain and hay were fed as soon as the calves would eat these feeds, and a vitamin A supplement was fed until the calves consumed enough hay to supply this nutrient. Since obtaining the above results, which seemed exceedingly encouraging, efforts have been made to increase the energy intake of the male and Jersey heifer calves reared according to methods 1 and 2 by either inducing the calves to consume grain earlier or by feeding feeds that could be more readily used by these very young calves. Jersey male calves reared according to method 2 and weaned at 60 days of age, have been induced to start eating grain and hay earlier in life; and, as a result of this, 5 of the 6 calves so raised reached normal weight at 6 months of age. There was a definite improvement in growth as a result of adding grain to the skim milk fed when the calves were as young as 5 to 12 days of age.

Raising calves on milk from cows fed only grain and corn silage. Since the diet of the cow may alter the composition of the milk, experiments were conducted in raising calves on colostrum and milk produced by cows fed no hay or pasture, but receiving a diet consisting of only grain and corn silage. The calves were daughters of dams likewise fed only grain and corn silage. The calves grew very well and there was no evidence of any deficiency in the milk which deleteriously affected their rate of growth. The milk produced by the cows on the grain-corn silage ration was tested for the unidentified growth factor that has been shown to occur in milk and was found to contain as much of this factor as was found in milk produced by cows receiving either pasture or a good grade of alfalfa hay. A study of this factor in the silage itself is in progress. One purpose of this work is to determine the cow's source of the growth-promoting factor which she puts into her milk, as well as the effect of the diet of the cow on the nutritive value of the milk.

The chemical and physiological properties of casein. The principal protein in milk (casein) and an important protein in the yolk of the egg (vitellin) are peculiar in their composition. Like other proteins, of course, they contain certain chemical units known as amino acids, but in addition to this they contain a phosphorus-containing group which apparently alters their

chemical properties. This phosphorus-containing group has been isolated, and information is being obtained on the way it affects the properties of the protein. Some of the results have been used extensively in the study of problems related to the industrial utilization of casein. Fundamentally, the work has an important bearing on the industrial and physiological use of these proteins.

The effect of low-calcium rations on the growth of dairy calves. Calves may grow normally from 6 to 18 months of age on rations consisting of grain and U. S. No. 3 timothy hay, and may grow as well on this ration without a supplement of bone meal as with it. These facts resulted from experiments carried on with groups of males and females fed hays containing 0.2 to 0.3 percent calcium, and with males fed a hay containing only 0.16 percent calcium. The hay fed was limited to 4.4 pounds daily. Four heifers have completed the 12-month period from 6 to 18 months of age on this ration, and have made what may be considered normal gains. There appears to be nothing abnormal about them. All of the animals received generous amounts of skim milk until they reached six months of age. A heifer that gained 465 pounds on the unsupplemented ration is a daughter of the animal that gained 507 pounds on the same ration. This daughter was born after her dam had made two lactations on this ration that averaged 10,239 pounds.

Work will be continued under this financial project (a) to determine what unidentified nutritional factors occur in milk, the role of these factors in animal nutrition, their distribution in feeds, methods of supplying them to the growing calf, their sources in the cow, the effect on the milk of varying their amount in the diet of the cow, and their physical, chemical, and physiological properties; (b) to develop a more satisfactory procedure for the determination of the vitamin A potency of milk, butter, and other milk products; to determine the vitamin A value of feeds that may be used to improve the vitamin A potency of butter; and to study methods of improving the vitamin A value of feeds, the effect of such methods on the value of other nutrients in feeds, and the conditions which may affect the utilization of the precursor of vitamin A; (c) to determine the chemical composition and properties of proteins, particularly milk proteins, in connection with their production and use in nutrition; (d) to determine, for calves and young dairy stock, the nutritional requirements for growth, normal health and optimum subsequent usefulness, and the most practical and economical methods of supplying these requirements; (e) to determine the nutritional requirements of the cow for milk production, for normal reproduction, for optimum nutritional conditions of the calf at birth, for the production of colostrum and milk of desirable nutritive properties, and for intensive production over a long life span; and to determine the nutritional value of feeds, the factors affecting the nutritive properties of feeds, particularly roughages; the effect of harvesting methods on the losses of feed nutrients and the value of the resulting feeds for milk production; and the effect of pasture treatments as measured by the quantity and quality of the milk produced.

Investigations of dairy herd improvement association practices in relation to efficiency of production:

The average production of all cows in dairy herd improvement associations last year was 8,325 pounds of milk and 338 pounds of butterfat. During the year feed and production records of more than 400,000 cows were tabulated and analyzed. The analyses of feed and production records continue to show that high-producing cows produce milk and butterfat more economically than low-producing cows. The feed cost of cows producing at the rate of 500 pounds of butterfat per year is 22½ cents. This cost increases as production decreases until it is 39½ cents for cows producing only 200 pounds of butterfat per year. Throughout the years there has been a steady improvement in dairy herd improvement association cows and herds. In 1926, approximately 45 per-cent of association cows produced less than 275 pounds of butterfat per year and only 15 percent of them produced more than 375 pounds of butterfat. The number of low-producing cows has decreased each year and the percentage of high-producing cows has increased until last year only 23 percent produced less than 275 pounds of butterfat per year and 34 percent produced more than 375 pounds. Approximately 100,000 cows in association herds averaged more than 425 pounds of butterfat.

Last year 1,779 sires were proved in dairy herd improvement association herds The daughters of these sires had an average butterfat production of approxi-mately 380 pounds. More than 99 percent of all sires proved in dairy herd improvement associations have daughters whose butterfat production averages more than the 182-pound average for all cows in the United States. Therefore any unselected group of association sires will be found to possess the inheritance for producing capacity to improve the production of cows in any average herd. The ninth annual list of proved sires containing the summaries of records of 1,886 proved sires was compiled. These sire lists provide dairymen information that enables them to select breeding stock with some degree of assurance that stock so selected will increase the producing capacity of their herds. During the fiscal year approximately 150,000 pro-duction records were received from the States. These records add to the production data on file which represents the largest accumulation of such data in the world. More than 2,000,000 production records have been recorded for approximately 800,000 cows. Dam and daughter data are being accumulated on approximately 90,000 sires.

In addition to the production data reported by dairy herd improvement associa tions in the various States, the Ayrshire, American, and Brown Swiss breed associations reported herd test data for approximately 13,000 cows.

During the year record keeping forms and methods employed in individual associations were improved so that production data may be obtained, recorded, and analyzed more efficiently. The development of the county-wide type of association with all the testing and record work being done in a central laboratory was studied and preliminary indications are that this type of organization has merit in that it provides a basis for offering dairymen the kind of herd testing service they desire. It is also serving as a means of placing more cows under some type of test and record keeping than has hitherto been possible.

The work of compiling and analyzing data obtained from the dairy herd improvement associations will be continued and dairy leaders supplied with current information which will aid them in making the herd improvement program more effective. The data will be used to prove sires and to discover families of animals possessing superior inheritance for high milk and butterfat producing capacity. The association herds are serving as a National breeding herd and are the principal source of breeding stock for improving the National dairy herd. All work will continue to be directed toward making the program as a whole more effective and productive in improving dairy herds generally.

(Continued on next page

Investigations of milk and milk products:

Dried milk keeping quality increased in low oxygen concentrations. Dried milk packaged in inert gases containing from 3 to 4 percent of oxygen keeps from 2 to 5 times as long as the same product packed in air. Investigations of the keeping qualities of dried milk in atmospheres of different oxygen concentrations show that the relationship between the percentage of oxygen concentration and the keeping quality in days is of a geometric nature and that in the region of from 0 to 5 percent of oxygen the keeping quality increases sharply with decreases in the percent of oxygen. For greatly extended keeping quality, the percent of oxygen concentration should be as low as possible. Through the use of a relatively high vacuum and a double evacuation of the container with an intervening period of from 3 to 7 days between evacuations, values of less than 2 percent of oxygen concentration are obtainable.

The amounts of gases adsorbed by dried milk decrease with the increase in the concentration of the liquid product. The rate of spoilage at different temperatures has been determined and reliable tests developed for indicating the rate and degree of spoilage.

Butter from butteroil. Previous work has shown that pure butteroil can be prepared and packed so that it will keep almost indefinitely under adverse storage conditions. It has now been demonstrated that by using small amounts of cream as an emulsion to impart body, butteroil may be used to form a reconstituted butter of satisfactory texture. The possibility of making a reconstituted butter from dried skim milk and butteroil is being investigated.

Storage life of evaporated milk. Slow physical changes in the constituents of evaporated milk occur in storage and impart undesirable characteristics to the product. A comprehensive study of all the factors involved has been initiated. The changes in the proteins seem to be of greatest significance. These in turn are affected by the processing procedures. Studies of viscosity changes in the product under different manufacturing procedures and storage conditions have been completed and provide the basis for further investigations.

Sterilized flavored milk. Flavored milks suitable for drinking directly from the container have been developed. This project was undertaken at the suggestion of the Quartermaster Corps, U. S. Army, and the evaporated milk industry. Milks flavored with honey, maple, chocolate, caramel, and fruit juices were prepared. The most acceptable was a caramel-flavored product. It has an excellent storage life and is now available to the Quartermaster Corps.

Penicillin as a possible aid to sterilization. Bacterial spores are an essentially dormant form of germ life characterized by an extraordinary capacity to withstand adverse influences of all kinds. The application of sufficient heat to kill resistant bacterial spores impairs the flavor and other properties of milk and its products. Under suitable conditions

spores revert to an actively growing or vegetative condition, and constitute a major problem in the preservation of food.

Investigations have shown that the spores of the most resistant species are highly susceptible to penicillin. Although some species are relatively resistant to penicillin, there seems to be an inverse relationship between the susceptibility of spores to penicillin and their thermal resistance. In sensitive species the drug permits the initial stages of germination of the spores to take place, but penicillin arrests further development and degenerative changes take place which ultimately lead to the death of the cells. The possible usefulness of penicillin in the preservation of milk will be studied.

Purification of lactic acid. Whey, a byproduct of cheese making, is an excellent source of lactic acid. The chief difficulty in the manufacture of edible and pharmaceutical grades of this acid is purification, as neither crystallization nor distillation of the acid is practical.

Lactide, a condensed form of lactic acid from which it can readily be regenerated by the addition of water, is readily distilled, but methods for its preparation have heretofore been inefficient. A method has been devised whereby pure lactide can be obtained continuously by distillation from impure concentrated acid by running the impure acid in a slow stream into concentrated acid held at the boiling point of lactide. The conversion is nearly 100 percent and the product is free of non-volatile impurities.

Coatings for lactic acid. A novel series of resins and lacquers consisting of metallic compounds of polymerized lactic acid has been made. These are fusible and somewhat less satisfactory than earlier lactic acid lacquers produced, but are easier to prepare. Aluminum, cobalt, copper, and manganese appear to give the best coatings.

Composition of casein in milk. Although the composition of the casein obtained from milk by curdling with acid is well known, the composition of its combination with calcium phosphate, which is the form in which it occurs in milk, has not been known. The chief reason for the lack of this basic information has been the difficulty of isolating the complex substance from milk without decomposing it. The casein complex of milk has been isolated by means of a high-speed centrifuge. Analyses indicate that the complex consists of the casein which may be obtained by acid-precipitation in combination with tricalcium phosphate.

Use of homogenized cream in ice cream mixes. In the manufacture of ice cream the homogenization of the entire mix prevents the churning of the butterfat by the beaters in the freezer and improves the quality of the finished product. However, the homogenization of the entire mix is not practicable for making ice cream on a small scale because of the cost of homogenizers and because machines of small capacity are not manufactured. Experiments conducted to determine the effect of using homogenized cream instead of homogenizing the entire mix show that homogenized cream from a modern

homogenizer can be used very satisfactorily for the preparation of ice cream mix, particularly if such stabilizers as alginate, methyl-cellulose and gelatin-mono-glyceride are used to stabilize the fat particle in the ice cream mix against churning. The quality of the product made from homogenized cream is usually indistinguishable from that made from homogenized mix.

Freezing and whipping properties of sherbets. Although sherbets have a tendency in the freezing process to take up a considerable amount of air, it is a tradition of the industry to limit whipping to a 20 to 30 percent overrun. Certain practices used to control overrun have a tendency to produce a coarser product than is desirable. Frequently, the sugar content of sherbets is recommended to be from 30 to 35 percent. Studies of the factors influencing the overrun in sherbets indicated that sugar contents as low as 25 percent were entirely satisfactory and that from the standpoint of texture the best product was obtained by drawing it from the freezer at the lowest temperature at which it would run. This method produces a sherbet of from 50 to 55 percent overrun. The studies also showed that the same basic principles developed by the Bureau in the freezing of ice cream apply equally to sherbets, namely, that each individual sherbet has specific whipping properties; other factors being constant the amount of air depends upon the temperature of the mix in the freezer; the lower the temperature of the freezer the lower the overrun; and the lower the temperature of drawing the finer the grain of the product.

Detecting use of raw or under-pasteurized milk in cheese making by phosphatase test. Several states have enacted laws requiring that milk used for cheese making be pasteurized or that the cheese be cured for a definite period of time. These laws emphasized the need for a satisfactory method to determine whether cheese was actually made from properly pasteurized milk. A phosphatase test, based on the effect of heat in inactivating the phosphatase enzyme present in milk, has been in common use for detecting under-pasteurization in fluid milk, but it was found that the test as used for milk could not be applied to cheese without modification. As a result of extensive laboratory experimentation, a new and improved modification of the test applicable to Cheddar cheese has been developed. This test has been applied to more than 350 lots of cheese and was found in all cases to be reliable. Further work is under way to develop methods of applying the test to other varieties of cheese and to goats' milk and cheese made from it.

Quicker ripening of Cheddar cheese. The Bureau has for a number of years advocated the use of pasteurized milk for making Cheddar cheese and has developed a reliable method for making a uniformly high quality cheese from pasteurized milk. A marked improvement in the quality of cheese has followed adoption of this method by cheese manufacturers. The industry has, however, raised an objection to the use of pasteurized milk for making cheese because the rate of ripening of pasteurized-milk cheese is relatively slow and the characteristic Cheddar flavor may not develop sufficiently if the curing process is accelerated. The results of investigations show conclusively that it is possible to speed up the ripening of Cheddar cheese by curing it

at 60° F. instead of at 50°, provided the milk is of good quality and is pasteurized. Cheese held at 60° F. was as fully ripened in from 3 to 4 months, and generally had a better flavor, than cheese held at 50° for 6 months. Thus, with pasteurized milk the industry can safely ripen Cheddar cheese at 60° F. in about half the time required for the lower temperature.

Investigations are now in progress to determine the relative effect of starters of various types on the texture and flavor of cheese cured at different temperatures.

Riboflavin by fermenting whey. Riboflavin (vitamin B_2) occurs naturally in whey in small amounts. Improvements have been made in the process of producing riboflavin by fermentation of whey. It has also been found that through the use of a yeast and, subsequently, a bacterium, relatively high concentrations of riboflavin in the whey can be produced.

Cheese from whey proteins. It has been shown that the proteins can be recovered equally well from Cheddar, Swiss, and Roquefort cheese whey. About 4 pounds of whey-protein curd can be obtained from 100 pounds of whey. Preliminary work indicates the feasibility of converting these proteins into cheese of the Roquefort type; also the possibility of converting the curd into cottage-type cheese or utilizing it as a base for cheese spreads.

Preserving cream by freezing. Large quantities of cream are preserved by freezing. Frozen cream is subject to physical changes in storage which, upon thawing of the cream, cause an oiling-off of the fat and other defects. The nature of the fat dispersion, the temperature history of the milk and cream, the rate of freezing, and the cream storage temperature, are factors concerned in this phenomenon. If cream is frozen quickly and held at a low temperature of storage, a normal cream may be expected upon thawing, even after a storage period of several months.

The effect of manufacturing conditions on the characteristics of dried whole milk, dried skim milk, and dried ice cream mix are investigations planned for the current year, as is a study of the packaging of these products for commercial use. Other projects included in the current program are (a) extension of the studies of the use of homogenized cream in ice cream mixes to include home-made types of ice cream, i.e., mixes low in serum solids and high in fats; (b) studies of the effect of variations in fat and other solids content on processing and drying ice cream mixes, and of the keeping quality of dried mixes; (c) studies of the effects of different kinds of lactic-acid-forming bacteria used in starters, variations in the making process, differences in the amount of salt added, and different curing temperatures upon the bacteriological and physical properties, the rate and extent of ripening, the development of flavor, and the quality of Cheddar cheese made from pasteurized milk; (d) the further introduction into cheese factories of methods developed by the Bureau for making Cheddar cheese from pasteurized milk; (e) the further development of the phosphatase test for determining whether milk used in cheese making was properly pasteurized; (f) development of a photometric method for measuring the amount of diacetyl (a flavor

compound) in cheese; (g) studies of methods for the recovery of whey proteins and the factors affecting the production of a high quality cheese of the Roquefort type from whey-protein curd, and the development of procedures for processing whey-protein curd in a form suitable for use in food spreads; (h) studies of problems concerned with the storage change in evaporated milk to determine whether the storage life of about 2 years may be extended to, say, 5 years; and (i) studies of the time-temperature relationships, especially in the flash pasteurization method, to produce a milk of a negative phosphatase reaction.

Administration and enforcement of the process (or renovated) butter act (regulatory): Further progress was made in improving the sanitary conditions in process butter factories. Three of the five qualified factories now have automatic butter printing and wrapping machines. A complete new floor was laid in one factory while another installed stainless steel tanks. Building alterations were also made in some cases. A sanitary score of 100 percent was given one factory by its City Health Department.

Consolidated procurement methods inaugurated last year to effect economies in truck operations and in the use of gasoline and tires were maintained throughout the year. Approximately 400 metal drums used on procurement routes were retinned as a result of recommendations made by the Bureau.

A change in manufacturing procedures was made at one factory on the recommendation of the Bureau as a result of research findings and a product of better keeping quality resulted. Studies of manufacturing requirements for making stable emulsions to insure a higher quality product were continued during the year.

The major problem confronting both the process butter industry and the Bureau is the infestation of packing stock butter with the larvae of the skipper fly during the summer months. The use of elaborate filtering and straining equipment does not always remove all such contamination. Despite the progress made from year to year in general factory sanitation and in the adoption of improved manufacturing procedures, such improvements are largely nullified because of lack of authority to condemn packing stock butter found unfit for processing. The inherent weakness in existing law has long been recognized by the Bureau. Corrective legislation drafted by the Bureau was introduced in both the 77th and 78th Congresses. It has again been introduced in the present Congress. To insure consumers of process butter a safe, clean, and wholesome food product continuous inspection and condemnation of unsatisfactory raw materials as provided for in the proposed legislation is necessary.

(b) Special Research Fund, Department of Agriculture
(Allotment to Bureau of Dairy Industry)

This budget schedule covers obligations under an allotment for special dairy cattle and dairy products research, as follows:

	Obligations 1945*	Estimated obligations, 1946*	Estimated obligations, 1947
Special Research Fund, Department of Agriculture: For dairy cattle and dairy products research	$60,605	$60,512	$60,185

*Includes overtime costs.

PASSENGER-CARRYING VEHICLES

The total estimate of $3,100 will provide for the purchase of two cars, their operation and maintenance, and for the maintenance and operation of four old cars.

The estimates provide for the purchase of two passenger-carrying vehicles at $1,050 each for further research in evaluating mammary gland development, for which an increase is proposed in the estimates. The dairy husbandmen engaged in the work will be required to visit dairy herds not accessible by common carrier to obtain data on the relative development of the mammary gland of a large number of young heifers in herds representing different breeds, different levels of production, and different conditions of management.

PENALTY MAIL ESTIMATE
Sec. 2, Public Law 364, 78th Congress
(Allotment to Bureau of Dairy Industry)

	1945	1946	1947	Increase (+) or decrease (-), 1947 over 1946
Category 1	$322	$600	$600	- -
Category 2	499	600	600	- -
Total	821	1,200	1,200	- -

Category 1 consists of bulletins, leaflets, and other technical publications furnished upon request and in answer to questions and problems raised in connection with dairy industry.

Category 2 consists of general administrative correspondence between the Bureau, its field stations, cooperating agencies, and other Government agencies and for mailing the documents involved in the business transactions of the Bureau.

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

(a) Salaries and Expenses - Preamble

CHANGES IN LANGUAGE

The estimates include the following proposed changes in the language of this item (deleted matter enclosed with brackets):

> For expenses [, independently or in cooperation with public or private agencies, including individuals,] necessary for investigations * * *
>
> * * * for the operation and maintenance of airplanes [and the purchase of not to exceed two] * * *

The first change deletes language, contained in the 1946 Agricultural Appropriation Act, relating to cooperation in effectuating the purposes of the appropriation. The sole purpose of the deletion is to shorten and simplify the item. The clause proposed for deletion is considered surplusage and, therefore, need not be retained in the annual appropriation act, the cooperative work being authorized by the Act of May 15, 1862 (5 U.S.C. 511), establishing the Department of Agriculture, as implemented by the Act of July 24, 1919 (5 U.S.C. 563-564). Elimination of the language from the annual appropriation act will not--in any way--change the scope or character of the work performed under this appropriation item, or the authority of the Department to cooperate with other agencies, institutions, organizations, or others in the conduct of such work.

The second change deletes the language authorizing the purchase of two airplanes. No such purchases are contemplated in the fiscal year 1947.

(Continued on next page)

(b) Field Crops

Appropriation Act, 1946		$1,983,900
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+240,000
Total anticipated available, 1946		2,223,900
Budget estimate, 1947		2,518,700
Change for 1947:		
Overtime decrease	-36,680	
Increase	+331,480	
		+294,800

PROJECT STATEMENT

(Note.--Amounts in parentheses opposite the alphabetically designated subprojects represent the details of the numerically identified main projects which immediately precede.)

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Cereal production, breeding, disease, and quality investigations	$633,750	$696,660	$726,000	+$29,340 (1)
(a) Barley	(65,650)	(71,480)	(71,840)	(+360)
(b) Corn	(154,850)	(171,570)	(172,140)	(+570)
(c) Seed flax	(28,780)	(36,010)	(36,190)	(+180)
(d) Grain sorghum	(40,630)	(42,010)	(42,250)	(+240)
(e) Oats	(41,280)	(42,660)	(42,950)	(+290)
(f) Rice	(43,260)	(46,460)	(46,610)	(+150)
(g) Wheat and rye	(218,570)	(240,100)	(241,940)	(+1,840)
(h) Weeds	(40,730)	(46,370)	(72,080)	(+25,710)
2. Cotton production, breeding, disease, and quality investigations	378,960	425,950	428,500	+2,550 (2)
3. Fiber plants other than cotton	61,596	65,550	65,800	+250 (2)
4. Forage crop production, breeding, disease, and quality investigations	317,680	409,520	476,800	+67,280 (3)
(a) Alfalfa	(61,380)	(68,490)	(108,730)	(+40,240)
(b) Clover	(26,640)	(29,770)	(49,900)	(+20,130)
(c) Soybeans	(33,050)	(76,160)	(76,270)	(+110)
(d) Lespedeza, cowpea, and miscellaneous legumes	(34,330)	(39,010)	(45,140)	(+6,130)
(e) Hay and pasture grass	(155,750)	(187,810)	(188,440)	(+630)
(f) Turf	(6,530)	(8,280)	(8,320)	(+40)
5. Rubber production, breeding, and disease investigations	29,780	32,330	150,100	+117,770 (4)

(Continued on next page)

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
6. Sugar-plant production, breeding, disease, and quality investigations	$355,020	$396,090	$425,750	+$29,660 (5)
(a) Sugar beets	(192,340)	(214,460)	(242,620)	(+28,160)
(b) Sugarcane	(121,780)	(135,660)	(136,850)	(+1,190)
(c) Sugar sorghum	(40,900)	(45,970)	(46,280)	(+310)
7. Tobacco production, breeding, disease, and quality investigations	147,100	161,120	161,850	+730 (6)
8. Food, feed, and forage crop investigations in Alaska	- -	- -	12,500	+12,500 (7)
9. Repair and reconditioning of physical facilities at field stations and laboratories	- -	- -	71,400	+71,400 (8)
10. Overtime pay	253,330	36,680	- -	-36,680
Covered into Treasury as miscellaneous receipts, Public Law 529	+126	- -	- -	- -
Unobligated balance	32,628	- -	- -	- -
Total available	2,209,970	2,223,900	2,518,700	+294,800
Transferred to "Salaries and expenses, Office of Information, Department of Agriculture"	+1,630	- -	- -	
Anticipated supplemental	- -	-240,000	- -	
Total estimate or appropriation (1945 adjusted for comparability)	2,211,600	1,983,900	2,518,700	

INCREASES OR DECREASES

The net increase of $294,800 for 1947 consists of the $36,680 decrease for overtime, and the following:

(1) An increase of $29,340 under Project 1, composed of:

(a) An increase of $3,960 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(b) An increase of $25,380 to develop methods for controlling weeds in irrigation reservoirs, canals, and distribution ditches, on ditch banks, and on irrigated farm lands in order to reduce maintenance costs and to prevent the loss of irrigated lands from production that results from noxious weed infestation:

The Problem and its Significance: The Bureau of Reclamation of the Department of the Interior is faced with a serious problem of controlling weeds on irrigation projects under their control, and has asked the assistance of the Department of Agriculture in solving the menace. Weeds in and around reservoirs, canals, and ditches increase maintenance costs, and serve as sources of infestation for farm lands. Weeds have taken large acreages out of production, and will continue to do so unless practical control methods are developed. This endangers the welfare of settlers and the repayment of Federal funds invested in reclamation works. Only one-seventh of all irrigated land is under the Bureau of Reclamation, so that the total problem is multiplied accordingly. Adequate control measures are not now available, and cannot be developed with present research support.

The Bureau of Reclamation estimates a $30,000,000 loss annually from weeds on the 66,000 farms on its projects. A weed survey on one project shows that 5,390 acres, or 7.4 percent of the irrigable area, is so completely infested with noxious weeds that no crops are grown. On the same project 9,156 acres, or 12.5 percent of the irrigable land, is so badly infested with noxious weeds that yields are seriously reduced. On an additional 23,381 acres, 32 percent of the irrigable area, there is infestation not yet in serious proportions but which will gradually become worse without adequate control measures. A total of 51.9 percent of the irrigable lands on this one project is infested in varying degree, all of which is or soon will become serious, and which also is a threat to the remaining acreage on the project. This is an extreme case, but in different degrees is repeated on other Reclamation projects. The general situation on other irrigated areas will average as bad or worse. Extreme weed infestation results in farmers being unable to maintain payments and in land being turned back to the district.

Waterweeds (tules, cattails, pondweeds, coontail, chara, etc.) reduce the flow of water and by desilting action accelerate the reduction of reservoir, canal, and ditch capacity. Heavy growth of such plants has cut the carrying capacity of canals and laterals by 40 percent or more on the Minidoka, Boise, and other projects. Such reductions make it difficult to deliver adequate water to crops, and extra labor and expense are required to remove the obstructions so as to prevent actual crop damage from too little water. Heavy water weed growth also prevents regulation of constant flow, with consequent lowering of operational efficiency. Silt deposits not only reduce flow but by diverting the current result in bank and channel bed erosion, often causing ditch breaks, and generally increasing costs of maintenance. Raising of water levels above the normal flow line in ditches increases seepage and the water-logging of adjacent lands.

Recent Bureau of Reclamation surveys show that waterweeds are increasing each year on those projects with comparatively clear water supply. On the Minidoka, Salt River, and Imperial projects, $20,000, $30,000, and $50,000, respectively, have been spent in one year to remove waterweeds from the irrigation systems. This does not include the cost of removing silt deposits resulting from these growths, nor ditch damage, seepage losses, or loss in crop yields from irregular water distribution.

Experience in attempting to handle these serious problems with inadequate methods has demonstrated the necessity of research to develop satisfactory procedures.

Plan of Work: Field headquarters will be established in cooperation with the Bureau of Reclamation and with State Agricultural Experiment Stations in the western irrigated areas, one in the central and one in the southern regions. Necessary laboratory facilities will be obtained wherever possible through cooperation with the Bureau of Reclamation or the State Stations, and field experiments will be conducted on the irrigation projects in cooperation with the Bureau of Reclamation, the State Stations, and farmers. Advantage will be taken of all existing Bureau of Reclamation and State Station facilities so as to insure the most effective use of personnel and funds. In some cases work may be done on other than Bureau of Reclamation projects with similar working arrangements.

(2) Increases totaling $2,800 under Projects 2 and 3 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(3) An increase of $67,280 under Project 4, composed of:

(a) An increase of $1,280 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(b) An increase of $66,000 to determine the causes of failures and low seed yields of alfalfa, red clover, and other small seeded legumes, and to develop methods of increasing seed yields:

Objective: To determine the effect of environment, diseases, variety, and pollinating and other insects on seed production; to develop management methods and varieties which will produce satisfactory and certain seed yields of pasture and forage legumes; and to establish methods and provide means for the more rapid initial increase of foundation seed stocks for farm use.

The Problem and its Significance: Legumes are the keystones of a permanent profitable agriculture, and the use of these crops should be greatly expanded in the adjustment of agriculture to a long-time sustained production basis. Sixty percent of all livestock feed is furnished by forage crops, and a twenty-five percent increase in

the acreage devoted to forage crops has been indicated as essential in a balanced postwar agriculture. An expanding use of legumes alone and in association with grasses is required for soil conservation and the maintenance of high soil productivity. These essential crops have not been as widely grown as they should be, in part because varieties adapted to all areas have not been available, and in part because seed supplies have been uncertain and as a result often too high in price. Stands of alfalfa have customarily lasted only two to three years in many areas, and the high cost of establishment has made farmers utilize the crop to a smaller degree than its great value justifies.

Approximately 67 percent of the 15,000,000 acres of the nation's alfalfa is grown in the northern states. During the past several years only about 60 percent of the seed available for planting in the area could be classed as northern adapted. This seed shortage leads to increased winter-killing because of lack of adapted seed.

Lack of seed supplies of adapted strains of the clovers likewise often leads to sowing unadapted varieties, with consequent loss of stand, low yields, and short-lived stands. At the present time there is an extreme seed shortage in several of the important legumes, including improved varieties of lespedeza. These shortages are of too frequent occurrence. The seriousness of the present problem is shown by the fact that Congress appropriated $12,500,000 for incentive payments to encourage legume seed production in 1944 and again in 1945. This helped to meet the emergency by encouraging the harvesting of fields otherwise too low in yield to pay costs, but does not solve the problem.

In many areas seed yields of these legumes has markedly decreased in recent years. These decreases are quite evidently not due to the same causes in all cases. In the eastern United States when boron is added to some soils alfalfa will set good yields of seed, although without boron none will be produced. Evidence from the breeding program shows that some varieties and strains of alfalfa will produce much more seed than others under the same conditions. Variations in available soil moisture, humidity, and temperature seem to be responsible for some cases of poor seed yields. Lack of pollinating insects seems to be the important factor in other areas. In some localities harmful insects may reduce seed set and yield. In general, however, little is known about all these various factors or how they may be controlled so as to increase seed yields. The development of practices, taking into account each factor important in each area, which will produce satisfactory seed yields is the only solution of the problem.

Plan of Work: The investigations would be cooperative with the State Agricultural Experiment Stations, and with the Bureau of Entomology and Plant Quarantine on those phases concerned with insects. The work would be located under irrigated and semiarid conditions in the west, under dryland conditions of the Great Plains and under more humid conditions of the east and south. Field, laboratory, and greenhouse investigations would be made on the effects of irrigation,

soil conditions, variety, and other factors influencing growth in relation to flower structure, pollination, and seed production. Management practices would be developed to insure optimum conditions for seed growing. Cross-pollination by insects as a factor in seed production would be studied in cooperation with the Bureau of Entomology and Plant Quarantine, and practices devised to utilize such activity to increase seed yields.

(4) An increase of $117,770 under Project 5, composed of:

(a) An increase of $370 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(b) An increase of $117,400 to continue experiments on methods of producing guayule rubber:

Objective: To carry forward field and laboratory experiments already well under way, directed toward finding the most economical methods of producing guayule rubber in order to preserve and extend the knowledge gained during the war so that we may be better prepared should another emergency arise. Particularly, to investigate important leads developed in the course of the Emergency Rubber Project which indicate that guayule can be a significant addition to a diversified agriculture in the Southwestern States, especially in dryland and marginal irrigated areas.

The Problem and its Significance: During the war, a large guayule planting program was conducted under the Emergency Rubber Project. Since this Project was started with only a small amountof available information, obtained from the operations of one commercial company, there was little past experience that could be used as a guide. An intensive program of production, breeding, and disease investigations was instituted.

Indications are that many of the standard production practices can be altered to get greater economy of operation and to lower the cost of guayule production. Under wartime conditions and with the retrenchment of the planting program, many of these new leads could not be adopted for field use. Some of these new findings give promise of so reducing the cost of guayule rubber production that American farmers in suitable locations in the Southwestern States may be able to produce rubber from this source at a profit under normal competitive conditions.

One of the more important of these new practices is direct seeding in the field. Where adapted, this method may eliminate the necessity for expensive nursery installations and transplanting costs.

The cost of production of plants in nurseries may be greatly decreased by furrow or flood irrigation, thus eliminating expensive overhead irrigation systems. Work under way indicates that the cost of harvesting may be decreased by new methods of mowing, leaving the roots

in the ground to regenerate new tops, thus avoiding replanting costs and obtaining quicker renewal of the crop. Results obtained in guayule improvement research indicate that yields can be greatly increased by the development of new plant types which grow more rapidly, attain a greater size, and have increased rubber content.

The development of guayule as a commercial crop in the Southwest would permit the economic use of extensive dryland areas and areas with insufficient water for growing alfalfa, cotton, and other high value crops. It would make for greater crop diversification in the Southwestern States and provide farmers with a new cash crop.

Plan of Work: Studies initiated under the Emergency Rubber Project would be carried to completion. Research would be conducted in California, Arizona, Texas, and New Mexico, with headquarters at Salinas, California, where laboratory and greenhouse facilities are available. The experiments would be continued on lands and with equipment and facilities secured under the Emergency Rubber Project. Some of the experiments are on leased land, and as these are brought to a conclusion, the work would be shifted to State and Federal experiment stations, where practicable, in order to take advantage of existing facilities and provide for more economical operation.

(5) An increase of $29,660 under Project 6, composed of:

(a) An increase of $2,860 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(b) An increase of $26,800 to determine means for control of Black Root disease of sugar beets in Michigan, Minnesota, Ohio, and other States in the humid area:

Objective: To discover control measures for black root, a disease which causes such serious losses as to jeopardize the existence of the sugar beet industry in many affected districts in the humid area.

The Problem and its Significance: Each year in the more eastern sugar beet districts of United States, the acreage of sugar beets harvested drops 10 to 15 percent below the acreage planted because the stands in many fields have been so decimated by seedling diseases that there is no prospect for a crop. When the farmer finds the stand of sugar beets being destroyed because the roots turn black and the young plants wither and die, he says "black root" is killing them. Attacks of soil-inhabiting and seed-borne fungi are responsible for the loss of seedlings. The disease is so serious that each year thousands of acres are abandoned. Furthermore, fields with poor stands are often carried through to harvest, a source of loss to the farmer and a liability to the factory.

The disease is prevalent in Michigan, Ohio, Indiana, Illinois, Wisconsin, Iowa, Minnesota, North Dakota, Nebraska, and western Washington--in short, wherever sugar beets are grown under conditions of natural rainfall. If the rainfall in early season is slightly in excess of normal, the disease causes serious damage and, with very wet spring conditions, the disease reaches epidemic proportions and causes widespread abandonment of fields. For example, in one year 25 percent of all planted acreage in Michigan was lost because of black root.

Replanting, although an added expense, is practiced to some extent but much of the acreage is simply given up. A replanted crop never gives the return that would come from a good stand of sugar beets planted early. The effects of black root in spoiling stands, together with the lower yields from replanted fields, are reflected in the low average yields in the affected areas, which, year after year, are the lowest in the United States.

At least five fungus pathogens are known which are capable of causing black root. Adequate detailed information concerning the disease situation in the affected areas is lacking. This must be obtained if successful means of controlling black root are to be discovered and made applicable to the range of field and climatic conditions under which the disease occurs.

In the humid area, continuance of sugar beets as a profitable crop and continued operation of beet sugar factories depend on effective solution of the black root problem. The disease strikes at a vital point of crop production, the initial stand. Stands reduced by black root invariably mean tonnages so low that the sugar beet crop is grown at slight profit and usually at a loss to the farmer. The low acre-yields of sugar beets, especially in Michigan, Ohio, Indiana, Wisconsin, Minnesota, Iowa, and other States, are discouraging farmers and causing them to turn to other crops. In irrigated areas, with water application subject to control, the stands of sugar beets range from 80 to almost 100 percent complete, whereas in many eastern districts the stands left in the field average below 65 percent, and often fall below 50 percent. These consist of the better fields that were retained and do not take account of the 10 percent or more of the planted acreage that has had to be abandoned. Each drop of 10 percent in stand below 85 percent of a full stand means a loss of at least 1 ton per acre in the sugar beet yield. The net result of poor stands is idle space in the field which uses labor, augments the weed problem, and gives no return.

Distressingly low acre-yields of sugar beets caused by black root have been experienced in recent years in eastern sugar beet districts, particularly those of Michigan and Ohio, where average yields have sometimes been no greater than 5 or 6 tons per acre. These are 3 to 5 tons below the earlier 10-year averages. These statistics and the state-wide prevalence indicate the very grave seriousness of black root as a threat to the sugar beet industry.

Plan of Work: Field and laboratory experiments, cooperative with state agricultural experiment stations, beet sugar factories, growers' associations, and farmers, would be conducted to discover and make trials of new measures for control of black root in affected districts. Headquarters would be established at the Michigan Agricultural Experiment Station, East Lansing, Michigan, with cooperative work at other state agricultural experiment stations in the affected area. Plant pathological investigations would be undertaken to determine for each major district the organism, or organisms, chiefly responsible for the losses, and field experiments would be directed toward discovery of practical control measures. Breeding investigations to develop resistant strains of sugar beet would be stressed as most promising for ultimate solution of the problem. Attention also would be given to factors contributing to effective disease control such as soil-fertility levels, crop rotation, and drainage.

(6) An increase of $730 under Project 7 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(7) An increase of $12,500 under Project 8 to obtain information on crop possibilities and native forage in those areas of Alaska suitable for agricultural development to obtain information on crops and native plants to guide agricultural settlers in the Territory:

The Problem and its Significance: The development of Alaska is an important link in the future security of the United States. The Territory will play an important role as a source of future mineral and timber supplies, and as a base for world air commerce. For protection and to serve air commerce, bases must be developed and maintained. All of this leads to the need for dependable local sources for certain essential foods and agricultural services. Public interest in these possibilities is being expressed, and indications are that returning servicemen plan to settle and farm in Alaska.

Farming in Alaska presents many problems unfamiliar to those who have farmed elsewhere. The long winters, the short growing season and its long day light, the relatively raw soils resulting from the climatic complex, and the effect of all these factors not only on growing the crops, but on their food and feed values as related to the longer winter indoor feeding period for livestock, must be understood for success. A great deal of information has been collected on crop possibilities for limited areas, but this must be expanded to include all of the areas potentially adapted to settlement.

Dairy and animal feeds are most needed for the area. The long winter feeding period of necessity requires that as much tilled land as possible be devoted to feeds and forage for use during this period. This in turn means that native forage should be utilized as range and pasture to the fullest extent possible during the growing period.

Studies to determine nutritional values, including minerals and vitamins, of native grass and browse plants are therefore of paramount importance. A determination of the length of time during which such range can be used, and conversely the periods during which the range cannot be used because of snow, and animals must be fed, must be made to provide the best balance in total feed supplies.

Similarly, the nutritional values of cultivated crops as foods and feeds should be determined with particular reference to those nutrient items that must be supplied in special amounts because of the long winter indoor feeding period. This is particularly true of minerals and vitamins. The possibilities of feeds for dairy animals need special attention because of these factors and their relation not only to the welfare of the animals, but also to the food value of the dairy products. The relationships of crop composition to the soils and the fertilizer and management practices necessary to give food and feed or requisite nutritional make-up is an integral part of needed information. These problems have not been attacked, and they must be met, in addition to the more obvious ones of what to grow and how to grow it. Some attention also should be given to vegetable and fruit crops that can be grown in the Territory.

Plan of Work: In cooperation with crop specialists of the Alaska College and Station, studies would be made of crop adaptation and responses on different soils in the areas promising for development, with similar studies of native range and browse plants in relation to soil types. Yield and quality data would be obtained together with information on optimum methods of management as determined by station and farm experience insofar as this is possible. Plant and grain samples would be analyzed chemically for nutritional values. Work during the first year must of necessity be exploratory in order to determine the items requiring most intensive attention later.

(8) An increase of $71,400 (Project 9, non-recurring) for repair and reconditioning work at field stations and laboratories of the Bureau:

Note.--Increases for this same purpose are requested under other appropriation items, as follows: $165,000 under "Fruit, vegetable, and specialty crops"; $50,000 under "Soils, fertilizers, and irrigation"; and $37,300 under "Agricultural engineering"; total, including "Field crops", $323,700. For brevity and convenience, a single justification statement is given here in explanation of the need for the work, with only a brief statement and a breakdown by locations under each of the other appropriation items involved.

Objective: To protect Government property from excessive deterioration and maintain facilities for the efficient conduct of the research program.

The Need: From the beginning of the war emergency, expenditures for upkeep of existing physical facilities at field stations and laboratories necessarily were kept at a minimum. A backlog of needs

exists for repair and painting of laboratory and office buildings, greenhouses, headhouses, implement sheds, seed storage houses and other buildings; and for repair and replacement of fences, irrigation and drainage installations, water supply and sewage disposal systems, roads, and other physical improvements. These needs should be met as soon as possible in order to protect Government property and maintain facilities for the efficient conduct of the research program.

Plan of Work: Since some of the individual repair and reconditioning jobs would be relatively small, it is contemplated that these jobs would be done by force account, hiring necessary labor and purchasing the materials required. Larger jobs would be done by contract. It is planned that the work would be completed in the fiscal year 1947, and the increases would be non-recurring. The backlog of repair and reconditioning work cannot be taken care of within existing funds without curtailing operating funds to the point that it would be practically impossible to conduct an effective research program.

The non-recurring increase of $71,400 under this item is estimated by locations, as follows (with approximate amounts indicated for certain items):

Cotton and other fiber crops:

Sacaton, Arizona: Painting and repair of 16 buildings, $15,000; grading and graveling roads, $2,000; repair and replacement of fences and walks, $2,000; replace water mains, $3,500	$22,500
Shafter, California: Painting and repair of 15 buildings	7,500
State College, New Mexico: Painting and repair of 4 buildings, repair of water and irrigation systems	13,000
Statesville, North Carolina: Painting and repair of cotton gin, heating plant, and other facilities	5,000
Knoxville, Tennessee: Painting and repair of 6 buildings	2,600
Greenville, Texas: Painting and repair of 18 buildings	7,500

Sugar crops:

Houma, Louisiana: Painting and repair of buildings, $3,000; replace oil burner with gas burner, $150; re-roof implement shed, $750; shell for surfacing roads, $250	4,150
Canal Point, Florida: Painting and repair of buildings and repair of platform-type wheeled trucks	2,050
Meridian, Mississippi: Replace inadequate water supply with deep well, casing, pump, etc., $3,400; concrete water storage tank with pump, $1,000; replace inadequate heating facilities with oil burner system, $2,700	7,100
	$71,400

CHANGE IN LANGUAGE

The estimates propose the following addition to the language of this item:

"and there shall be transferred to the Bureau of Plant Industry, Soils, and Agricultural Engineering, without compensation therefor, real property (located in the vicinity of Salinas, California) and personal property valued at not exceeding a total of $306,000, acquired for and heretofore used in connection with the Emergency Rubber Project; and there shall be included in the next annual Budget a statement in detail of the amount and value of the property so transferred."

The 1947 estimates include provision for continuing, under this appropriation, production phases of guayule research begun under the Emergency Rubber Project which is now in process of liquidation. The proposed change in language is to authorize the use, under this appropriation, of facilities, equipment, and materials secured for use on the Emergency Rubber Project.

(Continued on next page)

WORK UNDER THIS APPROPRIATION

Objective: The broad objective of the research program on corn, cotton, wheat, alfalfa, sugar beets, and other field crops, is to advance public and farm welfare, by developing information, methods, and materials to: (1) Increase efficiency and reduce costs of crop production; (2) insure ample and constant supplies of food and feed crops for the optimum nutrition of our people and their livestock; (3) insure supplies of fibers and other raw materials in the quantities and of the kinds needed for satisfactory industrial uses; and (4) increase farm income to encourage and support a high standard of living. More specific objectives are as follows:

(a) To develop improved field crop varieties, adapted to different regions and soil types, resistant to disease and other hazards, high in yield and quality and superior in handling, nutritional, or technological values.

(b) To develop practical control methods for crop diseases.

(c) To devise cultural practices giving optimum returns in crop yield and quality at a minimum cost.

(d) To devise practical systems of culture, cropping, and chemical treatments for the control of weeds.

The Problem and its Significance: This appropriation provides for improvement, disease control, culture, and quality investigations on the principal farm crops grown by American farmers. The corn, cotton, hay, wheat, oats, tobacco, soybeans, sugar beets, and other crops on which research is conducted had a total farm value during the past year of more than $11,600,000,000. These crops provide the principal part of our food, as food grains, sugar, and oils, and indirectly as feed and pasture for livestock; of our supply of fibers, oils, and other raw materials for industrial uses; and include as well the most important soil-improving and soil-conserving crops.

During the war technological advances developed by previous research contributed greatly to the tremendous wartime production of our farms. There are great opportunities to make further advances through research that will be equally important in helping farmers to meet future problems. Further progress in increasing efficiency and reducing costs of production is dependent on research.

Research has shown that improved strains of the different crops can be developed for each area, and that these strains, because of disease resistance or better adaptation to other prevailing hazards, may greatly reduce fluctuations in yield and quality. Improvements in cropping and cultural methods and seed treatments also reduce hazards. Proper attention to all of these considerations opens the way through research to maintain more certain production of our basic crops.

A continuing research program to improve the efficiency of our field crop production is essential to provide necessary information for readjustments which must be made in passing from emergency wartime production to a normal peacetime basis, and to protect the economic position of the American farmer in the immediate postwar period and during the years to follow. For example, cotton before the war was our most important agricultural export and still produces the major portion of the income for more farm people than any other crop. Unless we produce cotton of better quality than any other country, and are able to sell our cotton at world prices, we cannot recover foreign markets. Results of our fiber quality research have given us a definite advantage in quality, but these gains must be consolidated and work continued if American cotton is to continue to be the best in the world. With the world price per pound below the domestic price it is evident that increased efficiency at reduced cost is essential. The most logical way to reduce production costs per pound is by increasing acre yield, through research on nutrition, breeding, disease control, and cultural problems. This must be done if American cotton is to survive competition with foreign growths in world markets, and with synthetic fibers at home.

The necessity for a continuing research program also is emphasized by changes that are occurring year in and year out in a large and varied country such as the United States. The changes include the introduction of new crops and new varieties of crops, the introduction of new disease-producing organisms from outside sources, and the appearance of new, more virulent strains of old established diseases. Such changes present a never-ending series of potential catastrophies to American farmers, and constant vigilance and prompt attack by plant scientists on each problem as it arises contribute greatly to the stability of our agricultural production. Such vigilance and research must be continued if the food and other crop needs of our people are to be adequately supplied, and the American farmer is to compete successfully in world markets.

General Plan: The work consists primarily of field, greenhouse, and laboratory experiments in cooperation with State experiment stations, Federal agencies, farmers, crop-improvement associations, and other similar groups. Cooperative work is in progress with most of the States, and intensive studies are conducted at central points where special facilities are available for developing information on diseases and their control, resistance to cold and drought, and other factors important in breeding improved varieties.

Results of the work are made available to farmers through the State and Federal extension services, publications, the agricultural press, and correspondence in reply to direct inquiries. Every effort is being made to make available to farmers and agricultural workers helpful information on problems brought about by the ending of the war. Technical information and assistance are furnished action agencies for use in developing production goals and similar programs. Arrangements are made, in cooperation with State and with other Federal agencies to

insure adequate seed supplies of improved varieties, and to increase as rapidly as possible seed of new improved types.

Examples of Progress and Current Program:

Cereal Crops:

New disease-resistant barleys reduce production hazards. Barley production in the states of Wisconsin, Minnesota, and Iowa has decreased greatly in the past 10 years, due largely to unfavorable weather and to the fact that barley diseases have taken a heavy toll, making production unprofitable. Experiments are under way, in cooperation with the North Central state experiment stations, to develop better disease-resistant barleys for the area. Two new disease resistant varieties, Tregal and Mars, have been developed. Tregal, released by the North Dakota station in 1943 and grown on some 150,000 acres in 1945, is resistant to loose smut and has smooth awns. Mars, developed in cooperation with the Minnesota station, is resistant to stem rust and stripe, has stiff straw, high-yielding ability, and smooth awns, matures relatively early, and is of good malting quality. It ranked first in yield among varieties tested in the North Central States in 1943 and 1944. Some 1,200 acres of Mars are being grown under contract in Minnesota for seed increase in 1945.

Velvon 11, a still better barley for irrigated areas. Velvon, produced in cooperation with the Utah station and released in that State in 1937, had become the leading small grain variety in the state by 1942, and by 1944 was the leading barley on irrigated land in the inter-mountain area. Velvon 11 is superior to the original variety in that it has more resistance to the forms of loose and covered smut present in Utah, and is a better yielder. Approximately 8,000 acres of Velvon 11 were planted in 1945 and undoubtedly it will rapidly replace the parent variety, now grown on some 300,000 acres, mostly in irrigated areas.

North Carolina corn hybrids prove promising. During 1944, 160 North Carolina growers cooperated in producing approximately 3,000 bushels, or four times as much seed as in 1943, of the new corn hybrids developed in cooperation with the North Carolina Agricultural Experiment Station. A major portion of the 1945 acreage for seed will be devoted to production of five double crosses, U. S. Hybrid 282 and North Carolina Hybrids 1028, 1032, 1111, and 1114. The first three of these hybrids are yellow and the last two white. U. S. Hybrid 282 has an excellent performance record and is recommended for the Mountain areas of the State. North Carolina Hybrids 1028 and 1032 are recommended for the Piedmont areas, whereas North Carolina Hybrids 1111 and 1114 are best suited to the Coastal Plain section. North Carolina Hybrids 1028 and 1032 also have produced good yields in the latter area and are more resistant to lodging than the local varieties.

The use of Corn-Belt hybrids for early hogging-off has increased somewhat in North Carolina and other sections of the South in recent years. Some of these Corn-Belt hybrids yield well and provide feed much earlier in the season than the southern strains. However, the Corn-Belt hybrids lack husk protection and are severely damaged by weevils if allowed to remain in the field after ripening. They cannot be recommended in the South except where they are to be fed as soon as ripe.

Acreage of Louisiana corn hybrids expands rapidly. Seed of seven corn hybrids, developed in cooperation with the Louisiana Agricultural Experiment Station, was produced on 434 acres of crossing fields in 1944. Despite adverse weather about 8,000 bushels of seed were obtained. Seed production in 1944 was more than double that in 1943 and in 1945 is more than twice that in 1944. About 64,000 acres were planted to hybrid seed in 1945.

Seven of these Louisiana hybrids produced 7.4 bushels or 21.4 percent more grain per acre than the varieties with which they were compared in 1943, and 9.5 bushels per acre or 31.9 percent more in 1944. The relatively better showing in 1944 was made under conditions of severe drought, confirming observations made in other areas that good hybrids are more drought resistant than open-pollinated varieties.

Later maturing corn hybrids becoming popular in Kansas. Two new yellow corn hybrids and one new white hybrid developed in cooperation with the Kansas Agricultural Experiment Station are becoming firmly established in commercial production in that State. The acreage planted to hybrid seed in Kansas increased from 47 percent of the total corn acreage in 1944 to 63 percent in 1945. New Hybrids are later than most of the Corn-Belt hybrids, and fit into a region which previously has lacked suitable hybrids of proper maturity. These hybrids have been tested in Kansas for the past 4 years and have excellent performance records for yield and for resistance to lodging. Preliminary tests in other states indicate that they will be well adapted to growing in certain sections of Missouri and other states to the east.

Disease-resistant flax varieties protect production. Twenty years ago flax yields were reduced annually by the ravages of wilt, rust and, to a lesser extent, by pasmo disease. It rapidly became impossible to grow flax on land previously cropped to flax because of the increasing prevalence of wilt organisms in the soil. Although such enormous tolls from wilt seriously threatened flax production in this country, wilt was brought under control by the plant breeders producing such wilt-resistant varieties as Bison, Redwing, Buda and others. Now it appears that losses from rust soon will be similarly reduced. Rust reduced flax yields by an estimated 5,000,000 bushels in 1942, but new rust-resistant varieties are being grown on 65,000 acres in 1945 and sufficient seed should be harvested for sowing much of the flax acreage of the country in 1946. The new rust-resistant varieties are Arrow, Crystal, Sheyenne and Dakota. With control of the two major diseases in prospect, strains now to receive major attention are those having resistance to pasmo as well as resistance to wilt and rust.

Sorghum breeders supply material for new industry in America. In the short space of 3 years, Bureau scientists have supplied the country with the materials for a new industry, which should utilize the crop from some 40,000 or more acres of sorghum annually and give to the growers a return, based on present prices for this sorghum, of some $1,500,000 to $2,000,000 each year. From experiments conducted long before the war, scientists had discovered that certain varieties of cereals yielded a "waxy starch", similar to that previously obtained from the cassava plant and imported from the Dutch East Indies. From breeding stocks on hand a selection, later named Cody, with waxy starch and satisfactory grain characteristics for processing, was increased from only a few ounces for planting in 1942 to sufficient for producing some 30,000,000 pounds of grain for processing in 1944. This increase was possible only because two crops were produced per year, one in Arizona and California during the early spring and a second in the Plains region. Today, Cody supplies the needed starch for the pastry preparations of the country, whereas in 1942, a housewife could have carried the entire supply of Cody seed home in her shopping bag.

Midland sorghum saves man hours. Midland, first released in 1944, was planted on about 250,000 acres in western Kansas in 1945. Reports from farmers growing Midland indicate its favorable reception. It has short, stiff stalks that enable the crop to stand for some time after maturity with very little lodging. The stalks are nearly free from the so-called "weak-neck" character which causes many dwarf grain sorghums to break over after maturity, resulting in considerable loss. Midland can always be harvested with a combine, whereas many fields of Early Kalo must be cut with a binder, shocked, and thrashed in order to save the crop before lodging occurs. Thus Midland sorghum requires less labor.

New disease-resistant oat varieties for the Southwest. Osage and Neosho, early disease-resistant varieties of oats, have been developed for the spring-sown red oat area. They were first distributed in Kansas in 1945. About 450 acres of Neosho and 165 acres of Osage have been sown for seed increase. These varieties are the products of extensive cooperative breeding experiments with the Kansas, Iowa, and Idaho Agricultural Experiment Stations and this Bureau. Osage has short, stiff straw, a spreading panicle, plump yellow grains, fair test weight, high-yielding capacity, and will ripen at about the same time as the well-known Kanota. Osage is highly resistant to crown (leaf) rust and to the races of stem rust and smut ordinarily occurring in Kansas. However, it is known that at least one minor race of stem rust and one of smut attack it. Neosho has a very stiff straw, spreading erect panicle, light red grain, good test weight and excellent yielding capacity. It matures slightly later than Kanota and has more red oat characteristics than Osage. A comparison of the performance of these new varieties in Kansas indicates that both have exceeded the standard, Kanota, by about 15 bushels per acre on the average.

Five new rice varieties proving profitable to growers. Five improved varieties of rice, developed and released in the cooperative Federal- State breeding program, were grown on 48 percent of the southern rice acreage in 1944. The yield of the five varieties was 13 percent higher than that of the standard old varieties and in the rough and milled rice markets they also sell at higher prices. Based on OPA ceiling prices, and after deducting increased cost of seed, and harvesting costs resulting from the higher yields, the average acre value of Rexoro, Texas Patna, Nira, and Fortune was $83.53, compared with only $63.69 for Blue Rose, or an average increase of $19.84 per acre. The calculated increase in value from 376,494 acres amounts to $7,469,641. Likewise, the acre value of Zenith was $83.79 as compared to $70.40 for Early Prolific, or an increase of $13.39 per acre. This increase in value on 223,631 acres is equal to $2,944,419. Thus, the total increase in value resulting from the growing of these improved varieties was $10,464,060. Rice was grown on 8,074 farms in the southern rice-producing states in 1939, and assuming that the crop, owing to increased demands for rice due to the war, was grown on 10,000 farms in 1944, the increase in value ($10,464,060) is equal to $1,046 per farm.

New varieties of winter wheat spread harvest labor. Winter wheat growers in the Southern Great Plains are finding it possible to grow more acres of wheat with the same labor and equipment by using new early-ripening varieties for a part of their acreage, thereby distributing the peak load over a longer harvest period. One early variety, Early Blackhull, has been available for several years but has not been entirely satisfactory because of lodging and, moreover, millers have objected to the quality of the grain. Four new wheats recently released, Wichita, Pawnee, Comanche, and Westar, are expected to overcome some of these difficulties and extend the benefits of early ripening to a much wider area. These varieties have good to excellent quality of grain, and consequently are not discounted on the market.

Of these new varieties, Westar was released to farmers for the first time in 1944 for growing in the Texas Panhandle. The others have been in commercial production for a year or more. They have increased as rapidly as seed supplies permitted.

Breeding disease-resistant spring wheats pays dividends. New varieties of wheat produced and distributed to farmers since World War I added about 100,000,000 bushels to the 1944 crop of hard red spring wheat and about 300,000,000 bushels during the 4 years of World War II, as indicated by conservative estimates based on surveys of the acreage sown to each variety and on the comparative yields of the varieties in experimental plots and in farmers' fields. To the 4-year estimate should be added the equivalent of 25,000,000 bushels, the estimated increase in quantity of flour secured from the new varieties due to their higher average test weights. The superiority of the new varieties is very largely due to their resistance to leaf and stem rusts that have been prevalent on susceptible varieties to an unusual degree and in three of the four war years.

The distribution of Ceres in 1924, of Thatcher in 1934, and of Rival and Pilot in 1939 were all important forward steps. Thatcher was grown on about 12,000,000 acres in 1941. Because of its susceptibility to leaf rust, it has been largely replaced by Rival, Pilot, and other varieties which are resistant to both stem and leaf rust.

At the present time less than 2,000,000 of the 17,000,000 acres in the hard red spring wheat area are planted to stem and leaf rust susceptible varieties. Furthermore, the acreage of susceptible varieties is all in the western areas of the region where rust normally causes little damage. In 1944, rust extended farther west than usual with the result that many fields of susceptible varieties in Montana were so severely damaged that they were not harvested. Three new varieties--Mida, Newthatch, and Henry--were officially released for distribution to farmers in 1944 and are expected to further reduce the losses from these diseases.

New durums assure macaroni of excellent quality. The two new rust-resistant varieties of durum wheat, Stewart and Carleton, officially released in 1944, have been favorably received by farmers in the durum area of the Northern Great Plains and are regarded by processors as fully equal in quality to the best of the old varieties. The consuming public demands a macaroni that doesn't fall apart when cooked and one that has a golden yellow color. Stewart and Carleton are fully equal in quality to Mindum which has been regarded as the standard of quality by processors, and in addition they are highly rust resistant. Carleton also has stiff straw which is highly desirable in this class of wheat as they normally grow rather tall and often lodge. The acreage of these new varieties has so far been limited by seed supplies, but sufficient seed to supply all requirements will be available by 1946.

Sheep prove efficient bindweed eradicators. An efficient method of destroying bindweeds by grazing with sheep has been developed at the Cooperative Bindweed Control Experiment Station at Lamberton, Minnesota. Sheep have long been known to be fond of bindweed but it is not possible to pasture the weeds close enough to kill them without starving the sheep. The answer seems to be to grow a crop less palatable to sheep than bindweed on infested land. Such a crop supplies nourishment for the sheep at times when bindweeds are too small to furnish sufficient feed. Sudan grass and rye are such crops. Rye, sown in September and plowed under in June and the land immediately seeded to Sudan grass will provide pasture during most of the growing season. As sheep prefer the bindweed to these crops they eat the weeds first, keeping them grazed so close to the ground they eventually kill them. The rye and Sudan grass not only supply the additional feed necessary but aid in suppressing the growth of the weeds by shading them, if for any reason they are not closely grazed. By this practice bindweed has been completely destroyed in two seasons with little expense. The method appears especially useful for small fields near the farmstead where shelter and water are available for the sheep.

New chemicals for the control of weeds. A discovery of possible major importance in the field of weed control has recently been made in connection with studies of the so-called "plant hormones" or growth-regulating substances, conducted under a Special Research Fund project. One of these chemicals, 2,4-dichlorophenoxyacetic acid, was found to be deadly to certain plants when sprayed on the foliage in the very low concentration of one-tenth of one percent. These preliminary findings are being carefully and extensively tested, and if they are confirmed, weeds that can now be destroyed only with great difficulty and expense may be brought under control at a mere fraction of the present expenditure of labor and money. Not all plants are equally sensitive to this remarkable chemical. The grasses as a class do not appear affected, hence this chemical will probably be of no value against Johnson grass, quack grass, and the like. Against such destructive pests as bindweed, Canada thistle, Russian knapweed, and white top, 2,4-D, as it is called, may prove extremely helpful.

Especially promising results have been obtained in experiments on lawn weeds. A single spraying of a solution of 2,4-D, costing less than $5.00 an acre, has destroyed nearly all dandelion, buckhorn, lawn pennywort, and other weeds with no lasting injury to Kentucky bluegrass. The bent grasses are slightly injured by the treatment and some weeds, notably sheep sorrel, are apparently resistant to the spray. Much remains to be learned about 2,4-D, particularly the relative resistance of weed and crop species, and the proper rates, methods, and time of application.

Cotton Investigations:

Breeding superior varieties of cotton. In Georgia, the new variety, Empire, developed in the joint breeding program at Experiment, Georgia, continues to stand out as an improvement over its parent, Stoneville 2. One hundred and fifty tons of pure Empire seed, besides a considerable volume of reasonably pure seed in outlying areas, were saved in 1944 and planted in 1945. The Culloden one-variety community, Monroe County, planted its area of 1,500 acres in Empire entirely. The community around Haralson, Coweta County, planted Empire on 2,000 acres. One-variety community work in Pike and Spaulding Counties is including about 1,000 acres of Empire in each county. Numerous small lots of Empire seed are being sent out to other parts of Georgia and to other states.

Under the present breeding program in operation at the Georgia Experiment Station, an annual supply of about 75 tons of foundation seed will be available for establishment of new communities and for systematic replacement purposes in established communities. At the customary rate of 1/6 replacement annually this amount of seed should be adequate to maintain about 450,000 acres under organized one-variety community production.

Recent tests for wilt resistance in 15 new strains of Empire indicate that sufficient resistance may be developed in this cotton to warrant its use in the wilt areas of South Georgia also. Wilt susceptibility among these strains varied from about 2% to about 41%.

A high-quality, verticillium-resistant variety adapted to the irrigated Southwest has been developed. The verticillium wilt-resistant selection from the very susceptible but otherwise desirable Acala 1517 first tested in 1943 performed exceptionally well in competitive tests throughout the irrigated Southwest in 1944. This resistant selection, which was developed at the New Mexico Cotton Field Station, yielded well and in spinning tests exhibited the desirable quality factors that characterize the wilt-susceptible Acala 1517 parental type. This favorable showing has led to the decision by the New Mexico Crop Improvement Association to increase this resistant selection with the view of releasing it under the name of Acala 1517 WR (WR signifying wilt-resistant) if the 1945 tests are equally favorable.

Cotton improvement in standardized one-variety communities. The results of the fiber and spinning studies made by the Department as well as researches conducted by the textile industry place greater importance than was formerly realized upon variety in spinning efficiency and use values. This has resulted in a more general interest and appreciation of standardized production. Agencies working on postwar plans for cotton put standardized production as the number one practice that is needed to strengthen cotton's position at home and abroad.

The one-variety programs in 1944 were operating in 2,194 communities in 581 of the approximately 775 cotton producing counties, with a membership of 299,164 participating growers having a planted area of more than 7,000,000 acres of cotton. In thirteen of the fourteen cotton states in the main cotton belt where surveys have been made, it is estimated that the average extra cash return to farmers in the one-variety communities from larger yields and premium was $8.00 an acre or about $56,000,000.

Interest in ratooning American-Egyptian cotton appears to be increasing. Ratooning American-Egyptian cotton usually results in increased yields, early picking, and tendency to escape insect damage. Recent experiments indicate that undesirable fiber properties frequently associated with ratooned cotton may be partially or completely overcome by special irrigation practices and by topping the plants prior to flowering. These findings emphasize the importance of modifying irrigation and other cultural practices to minimize water stress for ratooned plants during boll formation.

Regional fiber-spinning studies emphasize the importance of improved varieties. These studies have shown that yarn strength that will be obtained from different varieties and strains can be predicted with considerable accuracy from fiber properties that can be rapidly measured. Strength of coarse yarns, in the range of 22s, appear primarily attributable to fiber strength plus fiber length, whereas for higher counts, 50s or finer, fiber fineness contributes about equally with fiber length and fiber strength. It was shown that yarn appearance, grade, or neppiness, was influenced by fiber fineness. These findings are of immediate practical value to the cotton breeder. It also has been shown that for both irrigated and non-irrigated growths, "grade and staple" are inadequate measures of the true value of a bale of cotton.

Investigations of fiber plants other than cotton:

Research with other fibers, such as abaca (Manila hemp), yucca, sansevieria, flax, hemp, certain imported fiber plants, and milkweed floss, has been directed toward developing improved practices and methods for increasing production of the fibers that can be grown in this country and toward aiding in the expansion of production in this hemisphere of abaca and other tropical fiber crops.

Western Hemisphere abaca continues contribution to national security. The greatly increased consumption of high-grade marine rope during the war period has long since exhausted the pre-war stocks of Philippine abaca fiber used in the manufacture of rope. Had it not been for the steadily increasing production of abaca in Central America, practically none of this fiber would now be available.

The greatly increasing size of our Navy and maritime shipping require a larger production of high grade marine rope. The quality of Central American abaca fiber continues to be below that desired for the better grades of rope needed by the Navy. Research is being continued on the relationship of fiber quality to variety, location of growth, age of plants, position in stem, method of decordication, and drying of the fiber.

The small cooperative experimental abaca project, established by the Department in the Republic of Panama in 1925, was expanded by an American plantation company during the war period into five large plantations. From the original planting of less than one acre, nearly 29,000 acres of abaca are now under cultivation in four different countries of South America. Five large fiber processing plants have been completed and are now in operation, and more than 20,000,000 pounds of Western Hemisphere abaca fiber have already been produced. The monthly production of this fiber is now approximately 2,000,000 pounds and will be still further increased. Until such time as the Philippine abaca industry may have been rehabilitated, the U. S. Navy and the American cordage industry will be entirely dependent on Central America for this urgently needed material. Certain problems have arisen in the machine decortication and drying operations which tend to lower average quality of the fiber. The Bureau has continued to cooperate in the solution of these problems and the further development and expansion of this important new industry.

Forage Crops:

Alfalfa seed production studies point the way toward a solution of the alfalfa seed shortage problem. Experimental alfalfa hybrids produced 309 pounds of seed per acre compared to 129 pounds per acre for Grimm in a seed productivity test in Utah. Other cooperative studies on alfalfa seed production showed that frequent irrigation of thickly planted, lodged alfalfa resulted in a complete failure of the seed crop. Where wild bees and honey bees were excluded from alfalfa, the plants produced 16 pounds of seed per acre compared to over 250

pounds per acre where normal visitation by beneficial insects brought about tripping and effective pollination. The control of harmful insects, such as Lygus bugs, by DDT resulted in increasing the seed crop from 46 pounds per acre to 332 pounds per acre at Logan, Utah, where the Lygus infestation was severe. These results indicate that intensified research may provide a solution to the problem of alfalfa seed shortages which have been evident during the past few years and previously at recurrent intervals.

Dixie crimson clover, a new, superior, hard-seeded variety for the Southern States. Dixie crimson clover is the name of a new, superior, hard-seeded variety developed by the selection and synthesizing of three identified strains. The hard seed characteristic of this variety permits it to volunteer in the fall from self-seeding, and good stands are established both in pastures and when used in rotation with cultivated crops. This variety appears to be widely adapted in the southeastern states, but more extensive tests are needed for confirmation. The development of this variety overcomes the serious weakness of poor stand establishment of common crimson clover.

New soybean selections from hybrid and introduced material have high oil content. Extensive nursery plantings of soybean selections from hybrid and introduced material indicated many high oil strains with desirable agronomic characters. In the north central region, the most promising selections ranged from 20 to 23.9 percent oil, and in the southern region from 20 to 24.8 percent oil. One southern selection, N-41-90, grown in twenty-one localities, averaged 22.6 percent oil. Commonly grown varieties of soybeans average 18 to 20 percent oil.

Hairy indigo, a new legume for the South. Hairy indigo, a new legume for the South, has been increased and seed released for general planting. This is proving to be a good legume for the lower South, both for soil improvement and forage.

Non-alkaloid, blue lupines show promise of supplying a grain crop for livestock in the South. Selected strains of "sweet", or non-alkaloid, blue lupines that give promise of supplying a grain crop for livestock in the South, were put into increase plantings and will be available for more general plantings in another season.

Rotation pastures increase production of feed in late summer. At Montrose, Pennsylvania, semi-permanent, or rotation, pastures produced nearly twice as much feed per acre as did the best permanent pasture. Rotation pastures produced on an average, during a three-year period, 51 percent more total digestible nutrients before July 15 than was produced on improved permanent pasture, while after that date rotation pasture produced 113 percent more T.D.N.

Progress made in increasing planting material of improved strains of grasses. Marked progress was made during the year in the cooperative increase of seed on vegetative material of improved strains of grasses for large-scale testing and for use by farmers. At Hays, Kansas, a

10-acre field of the Hays strain of buffalo grass averaged 633 lbs. of seed per acre, whilesa similar acreage of Elreno side-oats grama produced 320 lbs. per acre. One thousand pounds of seed of sand lovegrass were produced on 30 acres at Woodward, Oklahoma. At Tifton, Georgia, a 3-acre increase nursery of Coastal Bermuda grass furnished planting stock of this high producing grass to over 500 farmers in the southeastern United States. Nebraska, the leading state in bromegrass seed production in 1944, produced 46 percent of the total seed in the United States. Approximately 240,000 lbs. of the Nebraska production were certified Lincoln bromegrass, a superior strain best adapted to the central Corn Belt and eastern United States. Approximately 300 bushels of registered seed of Marietta timothy, an early maturing strain, were produced in Ohio for distribution to farmers in the latitude where adapted. In the southeastern states about 250,000 lbs. of seed of Tift Sudan grass, a disease-resistant, high producing strain were available for farm use in 1945.

New strains of Bahia grass prove drought and cold resistant: Two new strains of Bahia grass have been found to be well adapted to the sandy soils of Florida and southern Georgia that are subject to drought. In a pasture comparison between common Bahia, which is not entirely winter hardy, and Pensacola Bahia, a more cold resistant strain, at Brooksville, Florida, the former supplied 364 steer days grazing per acre with gains of .41 pounds per day, while Pensacola Bahia gave 714 steer days grazing with a daily gain of 1.12 pounds. Paraguay strain of Bahia, although not included in the test, appeared equally promising. Both of these new strains were more rapid in establishment and produced heavier sods than common Bahia.

Creeping Red Fescue, Paraguay Bahia, and Tall Fescue prove superior grasses for intensive use areas such as airports and road shoulders. Three grasses, not recognized generally as being useful for intensive use areas on airports, highways, etc., have been demonstrated as being quite superior to some of the grasses commonly used. These are (1) Creeping Red Fescue, well adapted to the northeast, east-central, and Pacific Northwest areas, especially on poor soils and shady lawns; (2) Paraguay Bahia in the deep south is excellent for airfields, highway shoulders, and recreation areas, especially football fields; and (3) Tall Fescus, especially the variety Alta, has proven to be adapted to areas lacking perfect drainage, has a great deal of wear resistance, and requires a minimum of mowing compared to other vigorous grasses. A valuable characteristic common to all three of these grasses is abundant production of a relatively large seed.

Rubber Production, Breeding and Disease Investigations:

Close contacts have been maintained with government agencies charged with responsibility for developing war-time sources of rubber. Assistance has been given by personal contact and through correspondence. Many analyses have been performed and much advice given in regard to rubber samples and potential rubber plants.

In tests of plants for domestic rubber cultivation, chief emphasis has been placed on continued tests of goldenrod, and the Russian rubber-bearing dandelions, kok-saghyz and krim-saghyz, with secondary emphasis

being placed on Cryptostegia and the Russian rubber-bearing plant tau-saghyz. Tests of goldenrod have consisted in rigid selection from 2,500 new strains, emphasizing leaf yield and leaf retention. These factors have been shown to have a predominant influence on rubber yield, particularly with close planting which has been demonstrated to be the cheapest method of eliminating weed competition and obtaining optimum yields.

With Kok-saghyz, emphasis has been placed on developing new strains combining large root development and high rubber content. With krim-saghyz, the effort has been to obtain a record of growth and rubber accumulation. Unlike goldenrod and kok-saghyz, which produce appreciable quantities of rubber in the first year, krim-saghyz does not produce significant quantities until its second year. Data have been obtained indicating possible yields of as high as 390 pounds of rubber per acre from krim-saghyz in the second year.

Cryptostegia selections developed under the emergency rubber programs have been assembled at the Plant Introduction Garden at Coconut Grove, Florida for preservation for future studies on the inheritance of rubber qualities as measured by the proportionate amounts of rubber and other substances in the latex. Indications are that valuable information can be obtained from further studies of Cryptostegia which can be utilized in the development of high-yielding or special-quality strains of other longer lived rubber-bearing plants.

The collection of high-yielding and blight-resistant strains of Hevea brasiliensis at Coconut Grove, Florida has been continued. Top-budding of these selections onto old seedling trees already has demonstrated the possibility of obtaining flowers and fruit earlier than would be possible under normal plantation operations in the tropics. First crops of seeds from cross pollinations of high-yielding strains with leaf-blight-resistant strains will be obtained during this next year and a considerable increase in the production of hybrid seed should be attained each year thereafter. These seeds will be sent to leaf-blight areas in Central America for testing of the progeny for blight resistance and for later yield tests of those found resistant.

Sugar Crops:

Improved, disease-resistant varieties now are mainstays in sugar-beet production. Sugar-beet varieties obtained by breeding research are improved in disease resistance and are otherwise better adapted to our sugar-beet districts. Thus, western sugar-beet districts subject to the devastating virus disease, curly top, now use curly-top-resistant sorts exclusively. In 1945 and 1946, "Improved" U. S. 22 will replace U. S. 22. Seed production of this variety in 1944 amounted to 1,797,000 pounds or enough to plant nearly 120,000 acres. The new selection maintains the high yield of its parent but is more curly-top resistant. Similarly, a selection of U. S. 15, designated as Improved U. S. 15, is superior to its parent because it has accessory qualities of increased resistance to both downy mildew and rust. The improved variety maintains the prized quality of its parent (U.S.15) in that it is slow to bolt when used in fall plantings in the Imperial Valley or in winter

plantings in the Coastal area of California. Other varieties when grown under such conditions go to seed in the first year and are threfore unsuitable.

The more eastern sugar-beet districts also have been benefited by this research. U. S. 215 X 216 because of its resistance to the fungus disease, leaf spot, is now the leading variety grown. By making reselections in both U. S. 215 and U. S. 216, the two inbreds that are grown together to produce the commercial variety, it has been possible to increase both leaf-spot resistance and productivity in the variety which results when these reselected inbreds are grown together in the seed field to produce F_1 commercial seed. This new introduction is to be designated as Improved U. S. 215 X 216. In 12 comparison tests in 1944, "Improved" was superior to U. S. 215 X 216 in production of sugar by 6.7 percent.

Sugar-beet breeding aided by discovery of male-sterility factor. Individual curly-top-resistant plants have been found with flowers possessing only abortive stamens. Such plants are able to produce seed only when pollinated by other sugar-beet plants. Discoveries of the Bureau in connection with onion breeding had revealed the manner of inheritance of the male-sterile condition. Finding of a similar genetic situation in sugar beets opens the way for capitalizing on male sterility in breeding research and in the practical operations of producing sugar-beet seed. Heretofore, production of single crosses in sugar beets has depended on chance cross-pollinations in the seed field planted with the two inbreds from which the hybrid was to be made. The percentage of hybridization obtained has been relatively low. By incorporating into breeding stocks the factors that bring about male sterility, 100 percent intercrossing can be obtained with sugar beets, thus making possible utilization of the vigor of hybridity to a degree comparable with that of corn hybrids.

Improvement of sugarcane varieties continues. Illustrating the need for continuing activities in sugarcane breeding, tests of a large number of new varieties from numerous seedling progenies permitted selection of several varieties that, because of their disease-resistance and other desirable qualities, appear outstandingly promising for commercial culture to replace less desirable sorts introduced during the past decade. These earlier introductions have remained in commercial culture in some districts because of reasonably satisfactory adaptation to certain soil and climatic conditions but they have become inferior in yielding qualities, probably because of progressive deterioration due to a complication of diseases. Replacement of the relatively inferior varieties is important to improve acre yields of both cane and sugar.

In anticipation of release in the near future of two new and improved disease-resistant varieties that appear especially suitable for culture in Louisiana, and one that appears adapted for culture on muck soils in Florida, supplies of seed cane are being increased in cooperation with the Louisiana Agricultural Experiment Station and with other cooperating agencies in Louisiana and in Florida. The background investigations for development of these varieties consisted of pathological, physiological,

and basic genetic studies, intensive surveys in the field, and agronomic tests at several substations. Numerous purposeful hybridizations had to be made, many thousands of seedlings individually tested for disease resistance, yielding capacity, quality, adaptability to the different sugar districts, suitability for mechanized operations, and for processing into sugar.

Flaming and chemical control effective against cane-field weeds. Because of acute scarcity of farm labor formerly utilized for controlling weeds on sugarcane lands in Louisiana, infestation by perennial weeds such as Alligator Weed and Johnson grass has reached alarming proportions. Prevalence of these weeds reduces yields of sugarcane, and in some areas infestation has become so extensive as to preclude growing sugarcane on land otherwise suitable. Studies in 1944 and early in 1945 confirmed preliminary results and showed that repeated flamings effectively controlled these weeds on sugarcane lands and on drainage ditch banks--sources from which the weeds spread. Initial spraying experiments in the spring of 1945 indicated that the new herbicide 2-4-D may prove effective for killing Alligator Weed without harming sugarcane at the concentrations used. The effect on Johnson grass was noticeable but less pronounced. Adoption of the flaming practice by many sugarcane plantations in Louisiana in 1945, together with promising results with 2-4-D in killing Alligator Weed, indicate favorable prospects for meeting the current weed problem by means of these labor-saving practices. Other experiments indicated that growing closely spaced soybeans or other smother crops on land intended for sugarcane and growing dense-shading types of cane in close proximity to drainage ditches may also prove helpful in weed control.

Progress in breeding sugar-sorghum varieties. Large-stalk, high-yielding types of sugar sorghum as represented in the new species and strains from 1944 African collections and from collections sent from India have broadened the scope and accelerated work in the sugar-sorghum breeding program. Until these new types became available, breeding research had to be confined to the low-yielding, but frequently high-sugar, domestic sorgo varieties grown in the United States only for sirup.

Results of tests, including those of 1944, had shown that because of low acre-yields of stalks and sugar, the domestic sirup varieties were not suitable for use as sugar varieties in Southern and Midwestern United States. The results from the Imperial Valley and from other southern locations in California held out more promise. Here, yields and sugar production from the domestic sirup types were more encouraging. Sorghum breeders have now crossed the large-stalk, high-tonnage imported sorgos, some of which are wild forms previously unknown, with the various sirup types needing improvement in stalk size and yielding capacity. Seedlings from approximately 200 crosses and from inbred varieties receive their first critical evaluation test in 1945. Preliminary trials indicate possibility of combining characters for large-stalk, i.e., high-yield, with relatively high sugar content.

Tobacco Investigations:

Heavy nitrogen fertilization produces poor quality cigarette tobacco. Recent field tests with flue-cured and burley tobacco show that although a liberal supply of nitrogen, either from commercial fertilizer or from manure and legumes grown in the rotation, tends to produce large yields of tobacco if other conditions are favorable, such tobacco usually does not have the desired characteristics of cigarette leaf. Unfortunately, this fact may not be apparent from simple inspection of the cured leaf. In the case of flue-cured tobacco, a moderately high supply of nitrogen may produce leaf of good appearance but having mediocre smoking qualities. The poor quality of leaf obtained with a distinctly excessive nitrogen supply will be indicated by the unsatisfactory odor of the cured product.

The problem is more complex with burley tobacco, which generally gives best results on relatively heavy, strong soils. Due to natural characteristics of burley tobacco, the nitrogen supply has comparatively little effect on the color of the cured leaf. Consequently, on the strong soils used in growing the crop, a high nitrogen supply produces very large yields of light-bodied, light-colored leaf, to all appearances having the qualities most desired in the cigarette grades. Actually, however, such leaf usually has an abnormally high content of total nitrogen and nitrogenous bases, including nicotine, that seriously detract from its smoking qualities. The tobacco grown under these conditions has been found at times to contain, for example, as much as 5 to 7 percent of nicotine. It appears that in the post-war period continued large scale production of tobacco having these characteristics will tend to lower the standing of these cigarette types as a whole.

New chemical treatment for weed and disease control in plant beds. Successful production of tobacco plants requires that the bed soil be free of weed seed and the germs of such soil-borne diseases as root knot and black root rot. Growers go to much expense to destroy weed seeds and disease germs, using various methods of sterilization such as burning with brush or plant bed burners, and steaming with boilers and large pans. There is great need for an inexpensive chemical treatment. As the result of extensive experiments, it has been found that a combination of one pound of urea, and 1/2 pound of calcium cyanamide, per square yard, applied to the plant bed in the fall, will give adequate control of both weeds and soil-borne diseases. At present, this treatment can be definitely recommended for the Coastal Plain area of Virginia, North Carolina, South Carolina, Georgia, and Florida where light sandy soils prevail. On the heavier tobacco soils of the Piedmont areas results to date have been somewhat less satisfactory and further work will be required before the treatment can be unqualifiedly recommended for these soils.

Oxford 26, the first wilt-resistant variety of flue-cured tobacco. In 1943, the discovery of adequate resistance to the Granville wilt disease was reported. In 1944, seed of the first flue-cured variety possessing this resistance, Oxford 26, was distributed and some 2,500 acres grown. The results were quite satisfactory, and on farms where

wilt had been serious previously, the growers estimated that yields were increased 25 to 50 percent. Evaluations of cured leaf made by commercial experts and by chemical analysis showed that the cured tobacco from the resistant variety was of good quality and suitable for cigarette production. Some 50,000 acres of Oxford 26 were planted in 1945. The introduction of this variety has increased the actual land value of hundreds of wilt infested tobacco farms, and it will eliminate an annual crop loss from wilt of some $2,000,000.

Transfer of wildfire resistance from Nicotiana longiflora to N. tabacum. Resistance to the wildfire disease of tobacco has been sought for many years. No variety of the cultivated tobacco, N. tabacum, has been found that possessed adequate wildfire resistance, but the wild species N. longiflora is immune to the disease. A successful inter-species cross has resulted in the isolation of a cultivated type tobacco that appears to have the full N. longiflora wildfire immunity. This selection was inoculated with wildfire four times in the plant bed and four times in the field in 1944 and again four times in the plant bed in 1945, and it has not yet become infected. Ordinary tobacco checks were uniformly and severely diseased. In 1945, in the plant bed, a severe storm caused extensive water soaking of the leaves of the ordinary, susceptible varieties, this condition developing around the numerous wildfire lesions. The resistant selection showed no infection and no water soaking. This wildfire-resistant selection is not a commercial variety but it will provide the basis for breeding the needed wildfire-resistant commercial varieties.

(Continued on next page)

(c) Fruit, Vegetable, and Specialty Crops

Appropriation Act, 1946		$1,572,000
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+205,000
Total anticipated available, 1946		$1,777,000
Budget estimate, 1947		2,061,000
Change for 1947:		
Overtime decrease	-30,800	
Increase	+314,800	+284,000

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Deciduous fruit investigations	326,200	396,520	423,220	+1,700 (1) +25,000 (2)
2. Citrus, avocado, and other subtropical fruit investigations	115,790	127,710	155,910	+700 (1) +27,500 (3)
3. Nut investigations	222,670	245,500	246,900	+1,400 (1)
4. Vegetable investigations	356,940	379,430	381,870	+2,440 (1)
5. Potato investigations	113,360	125,200	125,880	+680 (1)
6. Investigations of plants for landscaping and ornamental purposes and farm windbreaks	71,690	93,540	130,270	+430 (1) +36,300 (4)
7. Greenhouse experiments	71,360	82,200	82,410	+210 (1)
8. Methods of handling, transportation, and storage and market diseases of fruits and vegetables, investigations of	200,420	221,990	275,170	+1,180 (1) +52,000 (5)
9. Drug, oil, insecticide, tannin, flavoring, and related investigations	55,790	62,460	62,690	+230 (1)
10. Hop production, breeding, disease, and quality investigations	11,200	11,650	11,680	+30 (1)
11. Repair and reconditioning of physical facilities at field stations and laboratories	---	---	165,000	+165,000 (6)
12. Overtime pay	207,166	30,800	---	-30,800

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
Covered into Treasury as miscellaneous receipts, Public Law 529	+217	---	---	---
Unobligated balance	20,207	---	---	---
Total available	1,773,010	1,777,000	2,061,000	+284,000
Transferred to "Salaries and expenses, Office of Information, Department of Agriculture"	+990	---	---	---
Anticipated supplemental	---	-205,000	---	
Total estimate or appropriation (1945 adjusted for comparability)	1,774,000	1,572,000	2,061,000	

INCREASES AND DECREASES

The net increase of $284,000 for 1947 consists of the $30,800 decrease for overtime, and the following:

(1) Increases totaling $9,000, distributed by projects as indicated on the project statement, for placing on a full-year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(2) An increase of $25,000 under Project 1 to investigate the symptoms and host range and to develop control measures for and reduce losses from virus and virus-like diseases of stone fruits of the Western States:

The Problem and its Significance: The presence of virus diseases of stone fruits in the Western States has been definitely established only since 1935. Since then research has uncovered 38 virus or virus-like diseases, 7 of which are now of major economic importance and 6 are believed of potential importance. Success in the control of these diseases by preventing their spread through infected nursery stock or by eradicating diseased trees will be dependent upon positive recognition of all symptoms under varying conditions of climate and soil. Symptoms and interrelations of the diseases in the various fruit species and varieties as well as in native plants that may carry the virus must be determined.

The stone-fruit industry in the Western States comprises all the commercial production of prunes and apricots in the United States, most of the sweet cherries, and a large part of the peach crop.

The most important of the virus diseases include the following:

Peach mosaic--present throughout the area from Utah and Colorado to southern California. This disease has caused the loss of tens of thousands of trees in Colorado and southern California.

Western-X-disease of peach--present throughout the area from Utah to Oregon and Washington and possibly in California. Approximately 2 percent of the trees in the State of Washington were found infected in surveys conducted in 1942, and the disease has increased markedly since then.

Cherry rusty-mottle--distributed from Utah to Oregon and Washington and possibly in California. Potentially the most destructive of the diseases on sweet cherry.

Cherry mottle-leaf--distinct from rusty mottle, also found in certain of the native Prunus. In 1942 3.5 percent of the trees in Washington were affected and the disease is present in other western States.

Pink fruit of cherry--the disease is present in sour cherries in the Puget Sound area of Washington. Limited distribution at present, but very serious where found.

Buckskin disease of cherries--extremely serious in some parts of central California. May be identical with some of the diseases listed above, particularly with Western X-disease of peach.

Prune dwarf--a rather widely distributed disease of prune trees prevalent in many parts of the Pacific Northwest; probably virus in nature, but the possible interrelation to other viruses is not known.

The potential destructiveness of these diseases, if spread is not checked and control measures not taken, is very great and could easily result in virtual destruction of these fruit crops in large areas. Much more accurate information than is now available must be obtained in order to develop adequate control procedures.

Plan of Work: Three fruit virus nurseries isolated from commercial orchards will be used for basic investigations. One of these is near Wenatchee, Washington, one near Salt Lake City, Utah, and one near Riverside, California. Trees of various varieties and species will be inoculated with viruses present in the area and studied in order to determine the symptoms of the various diseases in varieties and kinds of stone fruits. Native species of Prunus will be studied to see if they are carriers of any of the diseases. In cooperation with the Bureau of Entomology and Plant Quarantine, studies will be made to determine the insect vectors that transmit the various diseases, and to determine the possibility of control of the diseases by control of the insect vector. Surveys will be made to

determine the presence of the various diseases in different fruit districts and individual sample orchards mapped to determine rate of spread. While principal centers of work will be in Washington and Utah, some work, in cooperation with State agencies, will be done in all of the Western fruit producing states. Growers and State and Federal control agencies will be kept fully informed of research findings.

(3) An increase of $27,500 under Project 2 to investigate the "quick decline" and tristeza disease of citrus and to develop control measures:

Objective: To obtain information on the nature and control of the very serious citrus decline disease; to test stocks in Brazil and the United States that may be resistant to the disease in order to safe-guard the important orange and grapefruit industries in the United States.

The Problem and its Significance: The tristeza disease was first found in South America in 1936 and has spread rapidly throughout the principal citrus producing areas of the La Plata River Valley and throughout most of the citrus districts of Brazil, killing practically all sweet orange and grapefruit trees grafted on sour orange rootstocks. It has not affected these fruits grafted on sweet orange stocks, but most of the plantings in South America were on sour orange and as a result the principal producing sections have been largely wiped out. Rate of spread into new areas has averaged about 60 miles a year. A similar disease has prevailed in South Africa for many years. In 1940 a few trees in California were affected with a disease known as "quick decline." Since that time this has spread to approximately 35,000 trees in 1945.

There are many points of similarity between quick decline and tristeza, although it is not yet known that they are the same. Both attack sweet orange and grapefruit trees grafted on sour orange rootstock but not on sweet orange rootstock. The cause of the disease is not known, but the present evidence indicates that it is probably a virus. Affected trees generally die in 1 to 3 seasons. Ultimate control will undoubtedly be establishment of orchards on resistant stocks.

Approximately half of the orange acreage in California and Florida and practically all of the grapefruit acreage in Texas are planted on sour orange rootstock. If these diseases become established in Florida and Texas, it is possible that all such acreages would ultimately have to be replanted using rootstocks resistant to the disease. Sweet orange stock is unsatisfactory in Texas and in certain areas of Florida because of its great susceptibility to root rot and gummosis. If tristeza or quick-decline became established in those areas, no stocks are now known that could be recommended for use in replacing infected orchards. There are almost continuous scattered citrus plantings from the present location of the disease in South America to our great citrus areas adjacent to the Gulf of Mexico. Thus in spite of quarantine measures taken in this country, there is a strong probability that

our orchards will ultimately become infected. Research in this case will require several years, and to be effective, must be completed before the disease reaches us.

It is essential that all possible stocks and varieties be tested for resistance to the tristeza disease. This can best be done by establishing plantings in areas of Brazil where disease takes out all susceptible trees. At the same time stock plantings should be established in Texas and Florida to determine the degree of susceptibility of the stocks to gummosis and root rot and to test their performance when topworked to different varieties and kinds of citrus fruits.

Plan of Work: To conduct the tests on the resistance of various rootstocks of tristeza, it would be necessary to send well-trained citrus specialists to Brazil to arrange for cooperative testing of all citrus types deemed to offer promise as stocks. Seed would be sent from the citrus species and variety collections now in the United States and be grown in Brazil and topworked to sweet orange and grapefruit varieties. Approximately six years would be required to grow the stock material and to complete the tests in that country. The men in charge also would conduct investigations on the symptoms of the disease, on methods of spread, and other related problems. At the same time extensive stock experiments would be set up in Texas and Florida, the work being closely coordinated with that in California which will be carried primarily by State agencies. These tests would determine the resistance of stocks to gummosis and root rot, extremely important diseases in most of our present citrus acreage. As a result of this work the best possible information would be obtained in advance of the establishment of these decline diseases in Texas and Florida in order that the best methods of handling them may be known if and when the diseases become established there.

(4) An increase of $36,300 under Project 6 to develop hardy disease-resistant ornamental and flowering plants, including dwarf flowering shrubs, dwarf evergreens, roses, carnations, and bulbs:

Objective: To develop improved and disease resistant varieties of flowering shrubs, evergreens, bulbs, roses, carnations, and other plants important in nurseries and home gardens; to investigate the diseases attacking these plants and to work out control measures for those diseases for which resistance cannot be secured; to develop improved methods of propagation, fertilizing, and producing these plants.

The Problem and its Significance: The annual value of the ornamental nursery industry in the United States is estimated at $296,000,000, about 80 percent of the total nursery business. Very little has been done in this country on breeding flowering shrubs and evergreens for our climatic conditions. As a result our nursery industry has depended on importing varieties that were developed in other countries where they were bred for adaptability to the climatic conditions

prevailing there. For this reason many sections of our country have a very limited choice of plant materials for home landscaping, park and roadside plantings. The advent of smaller homes has stimulated a demand for dwarf and spreading ornamental shrubs and evergreens. At present there are few low-growing varieties available. Most of our ornamental shrubs bloom in spring and early summer. Varieties for late summer flowering should be developed. At present the range of such popular ornamentals as lilacs is limited to Northern sections of the country and the equally desirable Crapemyrtle is limited to the South. More widely adaptable varieties of these two should be developed.

According to the Society of American Florists and Ornamental Horticulturists, the Easter lily is about a $25,000,000 industry. Before the war we imported an annual average of 22,000,000 to 25,000,000 lily bulbs from Japan, a 100 percent increase since 1922. Easter lily flowers are in demand every day of the year, although the peak demand is around Easter Sunday. Up until about 25 years ago Easter lily bulbs were produced in Bermuda. Certain virus diseases made their appearance, and in a few years destroyed the entire industry. The Japanese then started exporting lily bulbs, and prior to the outbreak of the war they controlled most of the world's supply. The Japanese lilies began to deteriorate about 10 years ago. This was caused by several factors, including the advent of serious virus diseases, improper handling after digging, and mixing of many varieties. They dug the bulbs at different times in each section and held them in storage until sufficient stocks were accumulated for shipment to the United States. Bulbs handled in this way always exhibited a variable performance from year to year, but no other bulbs were available for American florists. It has now been demonstrated that high-grade bulbs can be produced in this country provided it is possible to control certain virus and fungus diseases. Some large plantings, notably in Florida and Louisiana, have been lost because of virus diseases. Much research is needed on varieties, diseases, propagation, and method of handling to form the basis of a stable industry.

Roses and carnations are the two most important flowers, both in quantity and money value, now grown by American florists. The rose is also the most widely grown flower in the home garden. Practically all roses are very susceptible to the fungus diseases mildew, black spot, anthracnose, and canker. Disease resistant varieties should be developed for the home garden and everblooming climbing varieties are also wanted. In carnations certain virus diseases are appearing and unless information is secured this important florist crop is certain to suffer great losses.

Plan of Work: The work would be carried on at Beltsville, Maryland, the Pacific Northwest, the Great Plains area, in the Gulf Coast States, and on Long Island, New York. Hybridization work would be centered at Beltsville where greenhouse space and cold storage are available so that varieties may be flowered out of season and work carried on regardless of weather. The seedlings would be

grown in the various areas mentioned above and also in cooperation with florists and nurserymen in many sections of the country. In this way new seedlings can be tested for adaptability to a wide range of conditions. The important diseases of thse plants would be investigated and all new types tested for resistance. Other control measures would also be developed. Improved methods of propagation and handling would be worked out, including fertilizers and cold storage practices.

(5) An increase of $52,000 under Project 8 for investigations on suitability of various types of cargo and transport services, such as airplanes, auto trucks, refrigerator cars, and boats for shipping fresh and frozen fruits and vegetables:

Objective: To develop information on the essential transit conditions for fresh and frozen fruits and vegetables and to determine how these conditions can best be provided by various types of carriers.

The Problem and its Significance: In the period ahead many cargo ships and airplanes will be available and can be utilized for the shipment of agricultural products, particularly if modified or adapted to the needs of these commodities. Many refrigerator cars in heavy service during the war are worn out and need to be replaced by new types. This affords a unique opportunity to develop a program for the standardized construction needed to assure shippers of fruits and vegetables transportation services commensurate with costs.

The indispensable basis for such a program is more information than is now available concerning the efficiency or usefulness of various types of cargo and transport services, including their ventilating and air circulating systems, heaters and thermometers, and various methods of transit refrigeration, including refrigeration with dry ice and the use of CO_2 gas as a supplement to refrigeration. Such information can best be obtained through a planned program of transportation tests conducted by competent personnel. Committees representing the fruit and vegetable industry, including growers' and shippers' organizations, as well as transportation agencies, are agreed that the investigations are needed and have requested that the U.S. Department of Agriculture conduct them, pledging their full cooperation.

About 1,000,000 carloads of perishable fruits and vegetables are carried each year in refrigerator cars in the United States in addition to large quantities carried by trucks and boats. Better refrigerator cars and trucks and refrigerated changers in boats mean better transportation of perishable produce to market. The use of airplanes flying at high elevations where it is cold may make it possible to eliminate special transit refrigeration, particularly in view of the fast delivery service airplanes will provide. All of this in turn means prevention of loss from decay, overheating, freezing, and other deterioration in transit, with resultant enormous benefits to growers and shippers in increased prices for

their products. It also means correspondingly large benefits to consumers through the delivery to them of fresh and frozen fruits and vegetables in such a condition as to preserve their maximum attractiveness, freshness, and food value at prices which should be lower because of the reduction of losses due to faulty transit conditions or services.

The demand for high quality perishable products will undoubtedly be greatly increased. The proposed work to develop new and better transportation services would be a real and valuable aid toward meeting that demand, and at the same time reduce present heavy losses in perishable crops the growers of the country send to market.

Plan of Work: Professional workers and assistants would conduct tests with various types of new or converted equipment, including special cargo planes or cars built by the transportation companies for test purposes, to determine which afford the best protection to the various kinds of perishables and what changes are necessary to increase their efficiency. Tests would be necessary to determine what modifications or improvements are needed in boat cargo space and transport planes as well as in the refrigerator car construction program.

In order to secure the needed information within a reasonable time, that is, four or five years, 11 new men would be needed. It would usually be necessary to have three men working together on each test run. They would arrange the details of each test, supervise the loading and accompany shipments to destination, obtaining information enroute on temperatures, ice or fuel usage, and other factors. At points where the Bureau has no market representatives, it would be necessary for some of the men to keep the shipments under observation throughout the market period. Each group of three would probably be able to conduct about 6 such tests per year. Tests would be run throughout the year, including refrigeration during warm seasons, and heater or ventilation service during cold weather.

A wide variety of fresh produce shipped in various ways from the principal commercial growing areas would be studied. Many of the tests would be run from California, Oregon, Washington, Texas, Louisiana, Florida, Maine, North Dakota, and Idaho, where large tonnages of fresh fruits and vegetables originate at various times during the year.

(6) An increase of $165,000 (Project 11, non-recurring) for repair and reconditioning of physical facilities at field stations and laboratories, for which an overall justification statement has already been included in these Explanatory Notes under the appropriation "Field crops." This increase is requested to paint and repair buildings, greenhouses, and headhouses; grade and gravel roads, surface driveways; repair fences, culverts, and drainage and irrigation installations; overhaul water systems,

heating systems, and refrigeration units; and is essential to reduce the backlog of repair and reconditioning work which accumulated during the war. The increase is estimated by locations as follows (with approximate amounts indicated for certain items):

Chico, California: Paint and recondition 2 dwellings including waterproofing of cellar, laying of concrete floor, installation of heating system, electrical wiring, roofing, siding, etc. ..... $ 6,500

Fresno, California: Paint and recondition 3 frame buildings, including 2 laboratories and 1 residence, 2 greenhouses; overhaul heating plant; overhaul cold storage rooms and equipment; repair of fencing 3,500

Indio, California: Paint and repair 3 office and laboratory buildings, greenhouse, 8 cottages, 5 barns, sheds and garages; repair fencing; overhaul irrigation and water supply equipment 7,000

Greeley, Colorado: Paint and repair office and laboratory building, 2 dwellings; 11 barns, sheds, pump houses and related farm structures; 3 greenhouses; overhaul and recondition greenhouse heating plant, irrigation and water system and extend and alter greenhouse headhouses 13,000

Coconut Grove, Florida: Recondition water supply and irrigation system and install pump, pressure tank, and meters, and develop surface wells necessary because of salt contamination. Present water system was installed over twenty years ago as a temporary system, and was severely damaged in the hurricane of August, 1945. Recondition and rebuild old sewage system, installing septic tanks 15,000

Gainesville, Florida: Paint and repair 2 office and laboratory buildings and garage and storage house; recondition plumbing and electrical facilities in laboratories 5,000

Albany, Georgia: Paint and repair 4 garages and machinery sheds; overhaul plumbing and electrical facilities in laboratories ... 2,000

Cairo, Georgia: Paint and repair office and laboratory building and machine shed; rebuild fences 2,000

Fort Valley, Georgia: Paint and repair 3 office and laboratory buildings, greenhouse, 4 screen houses, 5 sheds and headhouses, and 1 residence; improve farm drainage; grade roads; build culverts; repair and recondition terraces 6,000

Savannah, Georgia: Paint and repair cottage, barn, office, greenhouses and laboratory and garage 4,000

Tifton, Georgia: Paint and repair greenhouse, headhouse, garage, and shed; overhaul and recondition heating system for greenhouse and laboratory; grade and surface walks, drives and building areaway ..... $ 2,000

Bogalusa, Louisiana: Paint and repair garage and storage building; rebuild fences; grade and surface roads and drives; improve culverts 2,000

Robson, Louisiana: Paint and rapair residence, office building, 8 barns, garages and sheds, and 3 cottages; overhaul and improve water system; repair or rebuild fences; grade and surface roads, and walks 6,000

Beltsville, Maryland: Repair heating system and paint and repair buildings 19,800

Glenn Dale, Maryland: Repair and replace greenhouse hot water heating system in use since 1919; put drains in boiler room and basement; paint greenhouses, office and laboratory buildings, implement and storage sheds and other service buildings; glass in porches, 2 cottages; replace pipes and install pumps in drinking water system 17,000

Meridian, Mississippi: Paint and repair 2 laboratory and office buildings, 6 residences and cottages, 2 crop storage buildings, greenhouse and headhouse, 3 sheds; repair and recondition concrete water reservoir; overhaul water system, clean out and improve storm water disposal; grade, surface, and repair roads 12,000

Charleston, South Carolina: Paint and repair office and laboratory building, 2 greenhouses and headhouses, 5 barns, implement sheds and garages, cold and dry storage building, 5 dwellings, screen house; overhaul refrigeration, dehydration and heating equipment in greenhouses, laboratory, storage house and other structures; repair and recondition water system, clean and improve farm drainage ditches, grade and surface roads and walks 14,500

Brownwood, Texas: Paint and repair 2 laboratory and office buildings, dwelling, 2 sheds and shop buildings; recondition and improve farm drainage and irrigation systems and domestic water system; grade and surface walks and roads 13,700

Cheyenne, Wyoming: Paint and repair 1 laboratory and office building, 9 dwellings and bunkhouses, 5 garages, 2 greenhouses and headhouses; recondition 2 storage cellars; repair, overhaul and improve irrigation lines and ditches; repair and rebuild fencing, repair roads and walks 14,000

$165,000

WORK UNDER THIS APPROPRIATION

Objective: The broad objective of the research program on fruit, vegetable, nut, ornamental, drug and other specialty crops is to advance public and farm welfare by developing information, methods, and materials to: (1) increase efficiency and reduce costs of production; (2) insure ample and constant supplies of those crops essential to optimum nutrition of our people; and (3) increase farm income to encourage and support a high standard of living. More specific objectives are as follows:

(a) To develop and make available as rapidly as possible varieties resistant to diseases and adverse climatic conditions, and having superior quality.

(b) To develop more efficient production practices, including fertilization, cultivation, pruning, spraying, and harvesting, to obtain maximum production with minimum use of labor and materials.

(c) To develop and disseminate information on control of diseases causing serious losses, including new fungicide materials for combating them.

(d) To devise methods of packing, shipping, and storing to reduce losses and economize in use of packaging materials and transportation equipment.

(e) To determine regions with suitable soil and climatic conditions for production of drug, condiment, insecticide, tannin, and other specialty crops, and the best varieties and methods of production for such crops.

The Problem and its Significance: These crops include the great health protectors in our diet as well as highly important staple food sources. Their importance in our economy is indicated by the following figures for the farm value of these crops in 1944 for major groupings:

Fruits	$1,266,889,000
Truck crops (commercial only)	843,321,000
Potatoes	547,118,000
Sweetpotatoes	132,774,000
Peanuts	175,380,000
Tree nuts	84,964,000

Any substantial reduction in the quantity or quality of these crops as a result of disease epidemics, faulty handling, unfavorable climatic conditions or other causes would mean serious losses, not only to farmers producing them but also to the health and economic welfare of the whole people. Continuous research to develop improved varieties, and production, handling, and storage methods, is of essential importance to farm and public welfare. Only by a continuing research program can advances already made be maintained and further progress achieved.

The large number of men rejected by Selective Service on physical grounds traceable to malnutrition is clear evidence that the nutrition of our people has been inadequate. In turn the greatly increased demands for food under the high income status and controlled prices of the war period, demonstrate that our population will consume a more adequate diet if made available to them at prices they can afford. Food crops higher in nutritive value and lower in cost, the result of crop improvement and more efficient methods of production, should contribute greatly to improving our general nutritional level by placing nutritious food within the reach of all our people.

Emergency needs for maximum production of all fruit and vegetable crops have made the results of our research program on problems of disease control, seed supply and treatment, variety adaptation, fertilizer requirements, and related production practices of primary importance. Information and materials developed through research are similarly necessary to the peacetime welfare of growers and consumers.

General Plan: The work consists primarily of field, laboratory, and greenhouse experiments in cooperation with State agricultural experiment stations, other Federal agencies, and growers. Work is conducted in 32 states, with intensive studies at central points where special facilities are available for developing information on diseases and their control, resistance to cold and drought, and other factors important in breeding improved varieties.

Results of the work are made available to farmers through the State and Federal extension services, the agricultural press, publications, and correspondence in reply to direct inquiries. Every effort is being made to make available to farmers and agricultural workers helpful information on problems brought about by shortages of labor, fertilizers, seed, metallic fungicides, etc. Technical information and assistance are furnished action agencies for use in developing production goals, fertilizer allotments, and similar programs. Arrangements are made, in cooperation with State and other Federal agencies, to insure adequate supplies of seed or propagating stock of improved varieties, and to increase as rapidly as possible such materials for new improved types.

Examples of Progress and Current Program:

Deciduous Fruit Investigations:

New sprays for prevention of preharvest fruit drop. Although preharvest sprays, discovered by USDA research, are widely used to delay or prevent the dropping of apples and pears, the compound now mainly used, naphthaleneacetic acid, has not proved entirely satisfactory for many varieties of apples. The limited period of effectiveness , with the consequent necessity for rather exact timing of the spray applications, has been the major difficulty. Research during the 1944 season under this appropriation and the Special

Research Fund indicated that the addition of Carbowax (a ployethylene glycol) to naphthaleneacetic acid considerably increased the intensity and extended the duration of the effect in preventing fruit drop. The greatest increase in intensity and extension of duration was obtained with the use of a compound not previously tested (2,4-dichlorophenoxyacetic acid) called 2,4-D in water at the rate of 10 parts per million. This compound offers considerable promise for use as a preharvest spray that can be applied rather early in the fall on all varieties and be effective in reducing or delaying drop for a period of possibly 30 days or more. The most effective concentration and the desirability of adding supplemental compounds remain to be determined.

Relative advantage of heavy and of light pruning of Anjou pears determined. To stimulate sufficient set of fruit for even a moderate crop, some dormant pruning of the Anjou variety of pear is necessary each year, particularly when the trees are growing in heavy soils. Ten years' research, in cooperation with the Oregon Agricultural Experiment Station, has shown that, with sufficiently frequent irrigation to maintain available soil moisture for normal fruit growth, a relatively light pruning annually will give as great an acreage yield as heavy pruning. When the market demand is for the larger commercial sizes of fruit, a relatively heavy pruning may be used to increase fruit size without appreciably reducing yield per tree. Under conditions where lack of irrigation water would result in moisture deficiencies and retard fruit growth, a relatively heavy pruning gives greater yields of fruit of desirable sizes than does light pruning.

Certain irrigation waters found to cause apple and pear tree decline. A general decline in tree vigor and varying degrees of chlorosis of apple and pear in the Pacific Northwest were found associated with the use of irrigation waters containing 200 or more parts per million of bicarbonate and low concentrations of sodium. The accumulation of carbonate around the feeder roots apparently interferes with normal intake of essential mineral nutrients. At present the only practical remedy is to avoid the use of irrigation water containing more than 150 parts per million of bicarbonate.

Control of the bitter-rot disease of apples with an organic fungicide. In apple districts where the bitter-rot disease is serious, the usual fungicide sprays containing sulfur, lime-sulfur, or insoluble copper do not provide satisfactory control. Experimental results obtained in Arkansas in 1944 indicated that the organic fungicide dichlorophenoxyquinone (now under the trade name of U. S. Rubber No. 604) gave outstanding control of apple bitter-rot, whereas bordeaux mixture plus oil and several organic fungicides did not. The dichlorophenoxyquinone did not cause any injury to the foliage, but it did cause a rather mild spotting of the fruit. Although this spotting affected only the surface of the apple, this fungicide cannot be recommended generally for bitter-rot control until additional investigations determine whether this effect can be prevented by modified methods of application.

New early peach for the South. Dixired, a new, very early, yellow-fleshed peach variety, has been developed by self-pollinating halehaven to provide an improved peach ripening with the Uneeda variety. In

Georgia, where Dixired has been tested most completely, its outstanding characteristics are unusual firmness, slow rate of softening for an early peach, and attractive appearance. Although released only in the spring of 1945, more than 75,000 nursery trees were budded for growers during the first season that budwood was available.

Citrus, Avocado, and Other Subtropical Fruit Investigations:

New chemical treatments control citrus fruit rots. Four organic chemical compounds in relatively dilute solution have been found to be highly effective in controlling the forms of stem-end rot and blue-mold decay that commonly affect Florida citrus fruits, at times causing losses of 10 to 50 percent. There are thiourea, thioacetamide, 8-hydroxyquinaline sulphate, and 2-aminothiazole. Their effectiveness is believed to be closely connected with their chemical structure, which is similar in certain respects, and with their quality of penetrating to the seat of infection in the tissues of the fruit. All these compounds have been tested under practical packinghouse conditions, and found to be satisfactory in one or more common methods of application. It remains to be determined definitely whether or not the minute quantities retained by the treated fruit would in any way make it unsuitable for human consumption. The experiments indicate that the amount of material that penetrates can be closely controlled by manipulating the strength of solution and the time of immersion.

Yield and quality of dates improved. Production capacity of date palms and quality of fruit can be increased by not removing any of the green leaves in pruning and by supplying sufficient water to maintain steady, vigorous growth of the young leaves throughout the summer. Checking leaf growth by reducing irrigation the latter part of the summer, when fruit is maturing, did not reduce loss from shattering, but did reduce total yield as well as the proportion of first-grade fruit; it also lessened fruit "checking" somewhat and induced earlier ripening. On the whole, the results are contrary to the idea of some date growers that such checking of growth reduces decay, shatter, and fruit "checking," without materially affecting yield or quality.

Nut Investigations:

Cultivation practices greatly affect pecan yields. In long-time experiments at Robson, Louisiana, involving 12 different cultural treatments, Stuart pecan trees that received a winter legume cover crop annually, which was turned under in early spring and was then followed by a sufficient number of cultivations to keep down grass and weeds, produced in 1944 at the rate of 2,871 pounds of nuts per acre, having a value of $775 at current farm prices. Trees of the same planting that have been grown in Bermuda-grass sod without cultivation produced at the rate of 426 pounds of nuts per acre, having a value of $115. This difference in crop value of $660 per acre clearly indicates the importance of cultivation and leguminous cover crops. Cultural treatments have a highly important effect on the quality as well as the quantity of nuts produced. Treatments that provide a high soil-nitrate level in the spring and a relatively low nitrate level in the autumn produced the highest percentage of U. S. No. 1 nuts.

Spray thinning of nuts increases the value of the pecan crop. Certain varieties of pecan set so many nuts that they are poorly filled and have a low market value. Trees that overbear one year produce few nuts the following year. An application of 4-1-100 bordeaux spray at the right time during bloom was effective in reducing the set of nuts, especially on the Moore variety. In 1944 the thinned Moore trees produced an average of 98 pounds of nuts per tree, whereas similar unthinned trees produced 118 pounds; but the larger nuts from the thinned trees were worth 6 cents more a pound, and $40 per acre more income resulted from the spray thinning. In addition, the thinning of the crop has resulted in a good set of nuts for 1945 on the sprayed trees, whereas the unthinned trees have set a very light crop.

Dusting gives commercial control of walnut blight. This most serious disease of Persian walnut can now be controlled with a 20-40-10 copper-lime-sulfur dust. Experiments show that 4 applications of this dust made at approximately weekly intervals beginning in the proper prebloom stage reduced infection from more than 30 percent to approximately 5 percent. Under the same conditions, a schedule of 3 applications of brodeaux mixture (6-2-100) costs about the same and was somewhat more effective, reducing infection to approximately 2 percent. It thus appears that dusting has a place when the available supply of labor is insufficient for spraying, and in emergencies when lack of spraying equipment or water makes spraying an impossibility.

Nitrogen fertilizer increases yield of tung oil. Nitrogen fertilizers have been found to increase greatly the production of tung oil per tree or per acre when properly applied, even in well cultivated orchards in which leguminous cover crops are grown. Experiments show that the annual application in March of nitrogen fertilizer carrying 35 to 70 pounds of actual nitrogen per acre, depending on the kind of soil and the age of trees, results in an increase of 45 to 185 percent in the production of tung oil. In all cases it has been found that this increase is due to (1) increase in growth of the trees, which gives a larger leaf area having a darker green color; (2) increase in number of fruiting bud per tree; (3) increase in average number of pistillate flowers and fruits that develop from each fruiting bud; (4) increase in percentage of kernel in the whole fruit, such that the percentage of oil in a given weight of whole fruit is increased notwithstanding the slight decrease in percentage of oil in the nut kernels. Tung trees must, therefore, be liberally fertilized with nitrogen to obtain maximum fruit yields and lowest cost per pound of oil.

Propagation of selected types of tung trees. Practically all tung orchards in this country are of seedling trees, but tests now under way indicate that vegetatively propagated trees from carefully selected and tested parents will prove superior to seedlings. Methods have been worked out whereby large numbers of trees may be easily, quickly, and cheaply propagated from such superior types of tung trees. Selected seed for the production of rootstocks is stratified in moist sand over winter and in the spring is planted in well-fertilized nursery rows. The seedling trees are budded to the desired types from

next mid-September. By proper handling throughout all subsequent operations the percentage of successful propagations and of successful establishment in the orchard are about equal to those for other orchard trees.

Vegetable Investigations:

New heat-resistant leaf lettuce released. A new heat-resistant, long-standing (or slow-bolting) leaf variety of lettuce, named Slobolt, has been introduced to the seed trade for commercial increase with a view to general sale in 1946. It is of special value to home gardeners because of its tolerance to summer temperatures over much of the country and its ability to yield a long succession of curly leaves of high quality without shooting to seed. It was found to be the only lettuce tested that is suitable for growing in the hydroponic installation of the Army Air Forces on tropical Ascension Island. Slobolt is grown exclusively there, from seed of the original stock. This is an excellent example of how "peace-time" projects of necessarily long-time character pay off in war time. The basic breeding work in isolating the slow-bolting character that was incorporated into this lettuce was begun nearly 15 years ago.

New double-resistant cantaloups produced. Two new disease-resistant cantaloups for the mildew-ridden cantaloup-producing area in the Southwest were introduced in cooperation with the California Agricultural Experiment Station during the year, and are in large-scale commercial production in 1945. These newest strains are named Powdery Mildew Resistant Cantaloup No. 6 and Powdery Mildew Resistant Cantaloup No. 7. Both are resistant to the two different and very destructive forms of powdery mildew that nearly destroyed the industry in the Imperial Valley. They are superior in shipping quality to their predecessor, No. 5, arriving at distant markets in much better condition and quality.

A new type of perennial onion introduced. A new type of onion called the Beltsville has been developed at the Plant Industry Station by crossing the white Portugal variety of common bulbing onion with the Nebuka variety of oriental onion. This new onion is a true-breeding fertile hybrid having double the chromosome number of the parents. In growth habit it is a perennial and has been developed for use as a green onion. Some bulbing occurs, but the plant does not "ripen down," making it much more widely adapted than the bulbing types. The sheath or edible portion is white. It is an excellent seeder, and the seeds are considerably larger than those of either parent. The young seedlings emerge quickly and make a rapid early growth. The Beltsville is resistant to pink root and smut and is immune to yellow dwarf.

Valuable new tomato hybrids produced. After long difficulties and dubious successes in efforts to cross the cultivated tomato with two wild disease-resistant relatives, authentic hybrids and fertile backcrosses to tomato were finally obtained. These wild South American species, rather distantly related to cultivated tomatoes, are Lycopersicon hirsutum and L. peruvianum. The first is highly resistant to mosaic and imparts an important degree of that disease resistance to its hybrid. Success in breeding for mosaic resistance now seems definitely achievable for the first time. L. Peruvianum is resistant

to many fungus diseases of great importance to tomato growers, and the new hybrid offers the first strong hope for success in developing marked resistance to these diseases that attack the leaves and reduce the yields and quality of fruit.

Now that this difficult gap has been bridged, further hybridizing, backcrossing, and selection can be vigorously carried forward toward production of improved home-garden and commercial varieties.

New hybrid gives hope of curly-top-resistant tomato. The virus disease known as curly-top or western blight often destroys tomato crops in the intermountain area between the Rocky Mountains and the Cascade and Sierra Nevada ranges. After many years' search for a curly-top-resistant tomato or tomato relative, and more years of effort to incorporate such resistance in a useful hybrid derived from the commercial type of tomato, some promising results are now being obtained. A wild-type kin to the tomato and known as Lycopersicon peruvianum var. dentatum was found to contain individuals resistant to curly-top. After much difficulty this wild type was finally hybridized with common tomato and the hybrid backcrossed to common tomato. Many of these back-cross lines contain an encouraging degree of curly-top resistance and will be used in further crosses and selections in efforts to develop as rapidly as possible excellent commercial types that will resist attacks of curly-top in those regions where it is often a limiting factor in tomato production.

Improved transportation for tomato transplants. Cooperative work in Georgia has developed methods and led to facilities for shipping tomato plants in iced cars to control disease and deterioration while enroute to northern growers. Up to three years ago it was standard practice to ship tomato plants by express without ice. Icing was tried experimentally and now shipment in refrigerated cars is standard practice, almost 100 percent, on carlot shipments. The reduction in loss of plants and the increase in quality retained in transit has been consistent, and has lew to the wide acceptance of the method.

Demonstrated bean rust control with dusting sulfur. Pending perfection and general availability of rust-resistant strains of field beans, artificial methods of rust control have been developed in cooperation with the Colorado Agricultural Experiment Station. When one thorough dusting with 20 to 25 pounds per acre of sulfur was given before the appearance of rust, yields of 40 to 45 bushels were obtained on irrigated land near Greeley; one dusting only, after rust was causing damage, gave yields of 34 to 36 bushels; and untreated areas in the same fields yielded only 6 to 8 bushels.

Exploratory vegetable-seed growing followed by commercial production. Exploratory vegetable seed growing trials in the nature of "prospecting" new areas possibly adapted to large-scale production were started in 1942 to locate those necessary for additional production capacity, since it was clear that this country, almost alone, had to become the vegetable-seed producer for the United Nations. Numerous tests of locations and production practices, in cooperation with State and other

agencies, in new districts of the West, have been promptly followed by large-scale commercial contracting for Government purchase and private sale. Seed-growing capacity in established districts in 1941 was quite inadequate. Phenomenal expansion was aided and guided in part by this work, with the result that no serious food shortages can be ascribed to lack of seed supplies. A sound, long-time vegetable-seed production research program is, however, essential to help place the American seed grower in a position to compete successfully with other producers. Our remarkable production has been obtained by relatively inefficient and costly methods, which must be improved through research if a favorable position is to be maintained.

Special attention is being given to lowering costs of production by increased mechanization and through "seed-to-seed" methods of growing biennial crops, thus eliminating mother-plant storage, and transplanting.

Peanut yields increased by better seed and close planting. In cooperation with the Georgia Agricultural Experiment Station, several seasons' work demonstrated that the planting of No. 1 grade shelled peanut seed (treated with Arasan, 2 percent Ceresan, or Spergon) gave yields definitely higher and more profitable than those from fields planted with so-called "peg" seed or small, undeveloped seed. Use of "peg" seed is common in many districts and should be discontinued. These cooperative cultural studies also showed profitable increases in yield from closer planting of peanuts. Planting at as much as twice the average rates for the respective types of peanut gave profitable increases far in excess of the additional cost of seed. Seed 3 inches apart in rows spaced 24 inches is the new recommendation for Spanish peanuts; and 6 to 8 inches apart in rows 30 to 32 inches apart for Runner peanuts.

Varieties of important vegetables classified for dehydration. Detailed varietal studies of vegetables with regard to their suitability for preservation by dehydration have been continued and extended during the year to include 19 varieties of lima bean, 5 of kale, 25 of spinach, and 30 of tomato. Long-time storage tests of dehydrated products of numerous varieties and kinds of vegetables studied earlier are being continued to the end of the useful storage life of these products. Results of dehydration studies during the past two years have been made available in 19 published articles.

Causes and control of discoloration of dehydrated potatoes determined. One of the most baffling and wasteful troubles encountered in the dehydration of foods has been the discoloration of white potatoes, either during or after processing. A published report of original work on this problem in the Bureau, together with a very exhaustive analysis of investigations by others, sets forth the various causes of development of abnormal colors such as reddening, browning, or graying of the product, together with recommended methods for prevention. Normal, unobjectionable color due to carotene in some varieties is also considered. The heavy rejections and losses of grade that have resulted from various discolorations, and the magnitude of the dehydrated-potato tonnage, make this a particularly useful and significant accomplishment.

Potato Investigations:

Two new potato varieties for the south. As a result of the work of the National Potato-Breeding Program in the South, two new varieties produced in cooperation with the Louisiana Agricultural Experiment Station have been named and are being increased for distribution. One of them, De Soto, is a red-tuber, high-yielding, midseason variety, a selection from the cross Triumph x Katahdin. The other variety, La Salle, is a white variety from a cross of Chippewa and a seedling selection of Triumph inbred. La Salle is slightly earlier than De Soto. Both varieties produce excellent yields from either fall-crop or northern-grown seed. They also produce well in the North.

Irrigation increases potato yields in the east. In cooperation with the New Jersey Agricultural Experiment Station it has been determined that the effect of drought on potatoes can be successfully and profitably overcome by artificial watering with portable irrigation equipment during critical periods of growth. Closer seed spacing and greater efficiency in the use of fertilizer are made possible through irrigation, resulting in larger yields per acre and greater profits to potato growers. In 1944 irrigated potatoes outyielded those unirrigated by 125 bushels per acre.

The potato rot nematode, another potato pest of recent importation. With the discovery in 1941 of the golden nematode of potatoes in one location on Long Island, followed in 1943 by that of the potato rot nematode on a restricted area in Idaho, the number of known major nematode pests of potatoes occurring in this country has increased to four.

As the name implies, the potato rot nematode causes rotting of the tubers. In heavily infested fields the rot may be so pronounced that harvesting of the crop does not pay. It has been found that a few specimens of the nematode entering a tuber propagate and multiply so rapidly that in a few weeks a tuber will be swarming with thousands of specimens. Investigations have established that the potato rot nematode is a separate species, and not identical with the teasel nematode and the bulb or stem nematode. The possibility now of recognizing specimens through structural characters will help to develop control and regulatory procedures.

Ornamental Plant Investigations:

Control of virus diseases makes easter lily bulb industry possible. For successful production of American Easter lilies it is necessary to be able to control certain virus diseases. The advent of such diseases destroyed this industry in Bermuda and made it possible for the Japanese to control the world supply of these bulbs. Prior to the war, Japanese lilies were showing various amounts of these viruses and the situation was becoming alarming to American florists who used these bulbs for forcing. As a result of our research on lily viruses we can now keep the diseases under control. It has been found that only two virus diseases are really harmful. One is the rosette disease from Bermuda,

and the other called "Fleck" is caused by the interaction of two viruses when both are present in the same plant. By proper methods of isolation, roguing, and non-introduction of diseased plants, a lily bulb grower can maintain his stocks in good condition.

A mica medium gives better results in starting seedlings. Much of the loss experienced by florists and nurserymen from poor seed germination and damping-off of seedlings can be avoided by using as a substitute for soil a sterile mica product known as Vermiculite. The flats are lined with fiber-resin inserts to form a reservoir, and about an inch of coarse gravel is put in. A small flower pot is set in the center of each flat for watering. The flat is then filled with the fine "concrete-aggregate" grade of Vermiculite in which the seed is sown. After the seedlings are up a weak nutrient solution made from a complete fertilizer is used in watering through the flower pot. Germination and growth are rapid by this method and disease loss is greatly reduced.

Organic fungicides control azalea flower spot. Very promising results were secured in the spring of 1945 in controlling the azalea flower spot disease. Two new organic fungicides, Dithane and U. S. Rubber No. 604, were very effective, giving a high degree of control and extending the flowering season as much as 3 to 4 weeks. Sprayed plants remained free from the disease even though they were only a few feet from unsprayed, heavily-infected plants. The effectiveness of the sprays was further demonstrated by spraying one side of a plant only. Such plants showed heavy infection on the untreated side and normal flowering on the sprayed side. Further details remain to be worked out concerning optimum concentrations, timing, and number of applications necessary.

Methods of Handling, Transportation and Storage, and Market Diseases of Fruits, Vegetables, and Flowers:

Preharvest sprays may hasten ripening of pears picked late. Preharvest sprays to retard fruit drop have come into rather widespread use for pears as well as for apples. In studying the effect of applications of a-naphthaleneacetic acid on the off-tree ripening of Bartlett pears, it was found that the rate of this ripening was accelerated with sprayed fruit that was not harvested until past optimum maturity, the degree of ripening being 2 or 3 times greater than in the case of unsprayed fruit. No undesirable effect was found when the fruit was picked at the right stage of maturity.

Overseas shipment of oranges possible in special packings. In shipping tests conducted for the Quartermaster Corps, U. S. Army, it was shown that Florida oranges wrapped in diphenyl-treated paper and packed in boxes lined with aluminum foil to retain the fumes provided good control of decay and shrinkage long enough to get shipments to troops in the European theater of war. Similar tests with oranges placed in bags having a diphenyl liner and carried in wood crates likewise gave satisfactory results, and it is reported that such shipments have been successfully made to military forces overseas.

Reduction in refrigeration costs possible in winter shipments of California oranges. Sixty carlot shipping tests were made with Washington Navel oranges from California to New York and Chicago to determine the relative advantages of using initial icing and ventilation during the winter and whether the ventilation service would be more satisfactory if the vents were allowed to remain open for the first 4 days on cars loaded with warm fruit, even though the outside temperature dropped below 32° F., the point at which the present operating rule requires vents to be closed. The results indicated that the modified ventilation service was as good as or better than initial icing and more satisfactory than "standard ventilation service" as now provided. The modified ventilation service should enable shippers to save the refrigeration costs incident to initial icing.

Careful sorting of onions desirable for overseas shipments. In handling shipments of onions of the Australian Brown variety to military bases overseas it was shown by experiments conducted in California that it is important to sort out onions having seed stalks instead of including them, as desired by the trade. In this variety, which is preferred for this use, there is normally a high percentage of onions with seed stalks at time of harvest.

Better regulation of temperature in tomato shipments obtained. A new method of icing cars loaded with "green-wrapped" tomatoes was successfully demonstrated in Texas. In shipping these tomatoes the problem is to retard ripening and avoid chilling the fruit. This can be done by maintaining the temperature around 55° F., but it is very difficult to accomplish this in an ordinary refrigerator car. The method used successfully in these tests was to ice the cars by blowing the bunkers full of snow ice, which packed down in a solid mass and closed most of the air channels so that air circulation was restricted, melting was retarded, and harmfully low temperatures avoided. This method appears to be a useful expedient for use with present refrigerator cars, but the close control of temperature needed to secure dependable delivery of tomatoes and certain other products in good condition calls for fundamental modifications and improvements in refrigerator cars.

Methods devised for hastening the precooling of sweet cherries. In studying methods of precooling sweet cherries in the Pacific Northwest (a procedure necessary to get the fruit to Eastern markets in good condition), it was found that during the first 4 hours cherries can be cooled as fast at 44° F. in moving air as at 31° F. in still air. At a given temperature cherries can be cooled about twice as fast in an air blast of 375 feet per minute as in still air. In ice water at 32° F. they can be cooled about 150 times faster than in still air at the same temperature. Hydrocooling of cherries in this way for as long as 7 minutes caused no cracking of the fruit or other adverse effects and appears to have some commercial possibilities.

Drug, Oil, Insecticide, Tannin, Flavoring, and Related Plant Investigations:

Fruit from tomato-stramonium grafts may involve a health hazard. An investigation in cooperation with the Alabama Agricultural Experiment Station has demonstrated that the yield of tomatoes can be greatly

increased in nematode infested soil by grafting the tomato stem on stramonium (jimson weed) root stocks. Analysis of the fruit, stem, and leaves of grafted plants indicates that synthesis of alkaloids occurs in the roots and that the fruits produced on grafted plants are extremely variable with regard to the amount of alkaloid present. Some fruits have been found to contain enough alkaloid to be a menace to health while others have relatively little alkaloid. Further investigations will be made to determine the conditions which cause the difference in alkaloid contents of the fruits from grafted plants.

Non-flowering character of castor bean responsible for low yields. The introduction of castor bean culture into this country during the first World War and on several occasions since that time, including recent attempts at growing a commerical acreage, met defeat largely because of the increasing number of plants which produced no flowers or seed or flowered so late in the year that no seed was formed. Investigations have now identified this nonflowering tendency as a genetically controlled character that occurs in certain strains. It has been demonstrated that the late flowering or non-flowering tendency can be eliminated from selected strains and that these strains will maintain a consistently uniform flowering period during the season and perpetuate this character with uniformity in succeeding generations.

Hop Production, Breeding, and Quality Investigations:

Foreign hop varieties and hybrids show limited adaptation. In a cooperative breeding and selection program with the Oregon Agricultural Experiment Station, most of the varieties of commercial hops grown in Europe, Asia and this country have now been assembled and grown in field tests. Particular characteristics and qualities of many of these plants have been determined for further possible use in a recombination of characters to produce new varieties. About 10 of the foreign varieties have yielded hops that appear to be worthy of further trials in this country, although none of these foreign varieties as such has proved to be superior to those now grown commercially in this country. Many thousands of crosses of these foreign varieties and seedlings from them have been made and they are now in various stages of field testing for performance. An isolation breeding yard of one acre has been replanted to consist of only female plants, that is, hop-producing plants of the best foreign varieties and seedlings that show some promise of resistance to the serious downy mildew disease.

Preliminary results of tests to develop better methods of preserving the quality of baled hops and to reduce transportation costs indicate that this problem is a difficult one. All methods tested for reducing the hops to a smaller volume by grinding and compressing also reduced the value of the hops because of more rapid loss of the soft resin content.

Treatment of the crown of the plants with calcium cyanamide was demonstrated as the most effective treatment in controlling downy mildew in the early infection stage, which usually serves as a source of inoculation for later infestation of the vines and hops. Considerably

less than one percent of the treated hills showed infected spikes as compared to 9 percent infection in untreated hills. Field dusting with a copper-lime dust and a copper hydro "A" dust for control after downy mildew infestation gave very inconclusive results that show only questionable value for the treatments.

(Continued on next page)

(d) Forest Diseases

Appropriation Act, 1946		$ 252,700
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+ 31,500
Total anticipated available, 1946		284,200
Budget estimate, 1947		321,500
Change for 1947:		
Overtime decrease	- 4,600	
Increase	+ 41,900	+ 37,300

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Diseases of forest and shade trees and forest products:				
(a) Diseases that affect timber stands, reduce lumber production, and influence logging operations (including heart rots, root rots, little leaf, diseases of turpentine pines)	$ 63,175	$ 72,600	$ 97,320	(+ $ 420(1) (+ 24,300(2)
(b) Diseases of young natural stands and and plantations (including white pine blister rust, chestnut blight, rust of southern pines)	48,139	52,600	68,900	(+ 300(1) (+ 6,000(2) (+ 10,000(3)
(c) Forest nursery diseases (including damping off, brown spot, storage and transit diseases)	2,397	3,100	3,130	+ 30(1)
(d) Decays and disease defects of lumber and other forest products including sap stains	84,541	79,080	79,520	+ 440(1)
(e) Diseases of street and shade trees (including Dutch elm disease and phloem necrosis)	26,515	59,520	59,860	+ 340(1)

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
(f) Diseases of trees in National Parks, parkways, recreational areas, of the National Forests, and other public undertakings, including stem rot of saguaro	$ 8,751	$ 12,700	$ 12,770	+ 70(1)
2. Overtime pay	31,160	4,600	--	- 4,600
Covered into Treasury as miscellaneous receipts, Public Law 529	28	--	--	--
Unobligated balance	1,294	--	--	--
Total available	266,000	284,200	321,500	+ 37,300
Anticipated supplemental	--	- 31,500	--	
Total estimate or appropriation (1945 adjusted for comparability)	266,000	252,700	321,500	

INCREASES OR DECREASES

The net increase of $37,300 for 1947 consists of the $4,600 decrease for overtime, and the following:

(1) Increases totaling $1,600, distributed by projects as indicated above, for placing on a full-year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(2) An increase of $30,300, distributed by sub projects as indicated in the project statement, to investigate forest diseases and determine control measures:

Objective: To develop and improve methods of tree-disease control that can be applied directly or indirectly through modifications in forest practices, in order to lower costs and increase the certainty of results in timber production, and protect our forest resources.

The Problem and Its Significance: The Forest Service looks mainly to this Bureau for investigations leading to control of forest diseases in 160 National forests covering 176,000,000 acres. Other Government and State agencies and private owners who operate millions of acres of forests also depend heavily on this Bureau, which performs the major portion of all forest pathological work in the United States. At present this work is inadequate to the needs in all forest regions and is extremely limited in some. Only cursory observations of diseases in some regions have been possible, although there are many important problems concerned with disease prevention as affecting forest management.

The forests have been depleted by heavy war demands, and timber reserves are at a critically low level. To build up reserves and to maintain the required supply of lumber and forest products to meet the nation's essential needs, reforestation and improved forest practices are being more intensively developed by Federal, State, and private agencies. Control of diseases that reduce yields and devalue products is essential to the success of this program. Annual losses from diseases exceed those from forest fires.

Examples of forest pathological work required to reduce losses from disease are:

(1) Learn how to judge from external conditions and symptoms the extent and probable rate of development of heart rots, to aid in timber cruising; and in deciding which trees or stands should be cut in order to forestall decay losses.

(2) In selective logging, determine how much branch or trunk wounding of trees left standing can be tolerated without leading to heavy decay before the next cut. These are projects of the highest priority; heart rots destroy 12 percent of commercial standing saw timber.

(3) Develop safe pruning methods for young trees of the principal forest species, in order to secure clean trunks free from decay as well as knots.

(4) Selection and propagation of disease-resistant trees for forest planting; especially 5-needle pines resistant to blister rust; select resistant trees for clonal propagation, and through controlled pollination develop production of seeds carrying the resistance factor.

(5) Develop control of mistletoe in young western pine stands; this disease is a major factor in decreasing growth on millions of acres of forest, and is ruinous to reproduction.

(6) Determine distribution, host range, and control methods of a fatal new root disease of western pine on several National forests.

(7) Intensify work on epidemic forest diseases of unknown cause and needing solution before control measures can be recommended, such as the disastrous little leaf of pine, which threatens the future of the most profitable pine on over 40 million acres of southern forest.

Plan of Work: Needed additional disease work would be undertaken by placing trained pathologists at field locations in the South, New England, the Southwest, and the far West. The work would be conducted mainly at existing laboratories and field stations, or on commercial logging operations or experimental forests of the Forest Service, and in cooperation with other agencies.

(3) An increase of $10,000 under Project (b) to develop and increase strains of blight-resistant chestnuts:

Objective: To develop and increase for farm woodlot planting, strains and stock of blight-resistant chestnuts as a source of durable poles and fence posts, and of tannin and edible nuts.

The Problem and Its Significance: Chestnut blight eliminated a very important source of tannin, poles, posts, and edible nuts from the South and East, rendering millions of acres of land less profitable because the products from the species that replaced the killed native chestnut are in general less valuable to the farmer. Such loss will continue until equally profitable strains of disease-resistant chestnut or of some other species which is not present naturally are established on the farm woodland formerly occupied by the chestnut.

A program of Oriental exploration, seed introduction, breeding, and experimental planting has demonstrated that Oriental chestnuts have promise as replacement for the dead American trees. Some strains that have been tested in different regions on various sites, although not equal to the American Chestnut in some respects, are worthy of trial planting. Many pure Oriental strains and hybrids between the Oriental and American chestnut should be multiplied and extensively tested. Some strains that are valuable for posts and as durable poles for rural electrification produce in addition abundant sweet nuts of larger size than the American nut.

The American chestnuts are still being cut for tannin and furnish about 60 percent of our domestic vegetable tannin supply for making leather. Many blight-resistant Oriental chestnuts have as high tannin content as the American, and some strains have much higher, showing promise of eventually replacing the American chestnut as a source of tannin. The selection, propagation, and testing of high-yielding Oriental strains should be intensified as soon as possible, since many years are needed to complete such tests.

Plan of Work: Experimental plantings of many strains of introduced and hybrid chestnuts in various climatic regions from Maine to Georgia and west to Iowa would be further evaluated, the most valuable blight-resistant strains determined, and arrangements made for supplies of seed. Through cooperation with the U. S. Forest Service, the Soil Conservation Service, Tennessee Valley Authority, State foresters, and other agencies, the trees would be grown and distributed to farmers through the respective agencies for woodlot plantings. These larger plantings would serve as large-scale regional test plots of different selected strains. In addition, the production of improved new blight-resistant strains would be expedited by increased breeding, and the best of these propagated for private orchard plantings for seed production. The increased funds would be used at our laboratories at the University of Georgia, Athens, and at Beltsville, Maryland.

WORK UNDER THIS APPROPRIATION

Objective: The broad objective of the work in forest diseases is to increase the value of trees and to enhance the returns from timber and forest products, by reducing the occurrence of diseases and decay, or by the development of management practices which reduce the detrimental effects of diseases. Currently important aims are to preserve the health of forest and shade trees and to prevent damage from decay organisms to wood in its numerous uses. Immediate objectives include development of (1) tree varieties resistant to specific diseases; (2) forest-management practices to avoid losses from heart rot and other diseases; (3) improved methods of inspection and grading to avoid deteriorated wood without needless rejection of valuable material; and (4) improved practices which will prevent decay in aircraft, boats, buildings, and other places where wood is used. To attain these objectives, attention is given to causes of disease and deterioration, to factors by which they are influenced, and to methods of control.

The Problem and its Significance: Diseases cause great damage in forests. Heart rots alone make it necessary to cull nearly 11 percent of the gross volume of the annual saw-timber cut. Diseases not only destroy wood but increase logging costs and labor requirements because many trees when cut are found to have too little sound wood to cover the expense of felling and bucking.

It is important not only to combat disease but also to learn how to better estimate the damage already done. Recent trends in forestry intensify these needs. Fortunately, partial cutting is being substituted for clean cutting in many areas. In relatively few timber species has it been worked out how to tell which trees are decay-liable and which can be safely left standing until a later cutting, or how much the wounds made during selective logging increase the decay hazard to the trees left standing. Improvement operations in second-growth stands may fail if disease aspects are neglected. Forest and erosion-control plantings are hampered by diseases that dwarf or kill young trees. Disease epidemics destroy shade and ornamental trees, leave city streets without trees, and reduce property values. Much of the lumber now being sold is from second growth and has a high proportion of sapwood, which makes it liable to decay. New problems have arisen in the protection of boats, aircraft, wooden buildings, and of wood and fiber containers. Production of rosin and turpentine is a major industry in the South. Safeguarding the new methods for stimulating rosin flow and controlling diseases that affect the freshly cut faces of trees are important factors in this industry.

General Plan: This work is directed to the solution of current disease problems in connection with timber management, wood utilization, and destructive forest and shade tree disease epidemics. Laboratory and controlled field tests are conducted in cooperation with the Forest Service, the Soil Conservation Service, the Bureau of Entomology and Plant Quarantine, the National Park Service, State experiment stations, municipalities, and nurserymen. Most of the field workers are located at Forest Service headquarters.

Progress and Current Programs:

Pathological factors in the production of turpentine and resin: Treatment of chipped faces of turpentine pines with sulfuric acid greatly increases the flow of gum so urgently needed now, but questions have been raised as to the effect on the trees. Tests in cooperation with the U. S. Forest Service show that after 4 years of acid treatment the trees are in vigorous condition, with no indication of any decline in health. Chemical tests indicate that the treated trees have suffered no impoverishment of their normal carbohydrate supply. A large-scale study showed that acid treatments did not predispose the trees to dry face, a destructive disorder resulting in the cessation of flow of gum.

Little-leaf disease of pine: Little leaf disease is now clearly established as a very serious factor in reducing the production of shortleaf pine saw timber on large areas in the southeastern Piedmont. The disease continues to kill trees in areas where it has been present for several years, and has appeared in new areas where it was not known to be present in 1941.

The cause of little leaf remains obscure and the disease is one of the most important unsolved silvicultural problems in the South. It occurs on all of the Piedmont soil types and is not related to weather or soil moisture conditions. Analyses of soil and of needles from diseased pines show no deficiencies in nutritional elements except nitrogen. Nitrogen content was shown to be low in the diseased leaves and the trees have responded quickly to heavy applications of nitrate of soda to the soil. Deficiency of nitrogen in the diseased trees may not be due entirely to nitrogen depletion of the soil. It may have some other significance in relation to the complex little-leaf problem and is being investigated. Researches are also focused on the possible role of soil- and root-inhabiting fungi in the development of the disease and on the possibility that an infective virus may be the casual agent. These problems are difficult and not easily or quickly solved.

On an area of 1,000 acres in the Sumter National Forest in South Carolina the possible value of eradication for control of little leaf is being tested, as reported previously. Frequent inspections of the area are made and newly affected trees are removed as fast as they develop positive symptoms. If the incidence of new cases is reduced by eradication, when compared with the incidence in an adjoining check area on which diseased trees are not removed, it will cast light on the possible infectious nature of the disease and on the practicability of eradication for its control.

In the meantime recommendations previously made for management of stands affected by little leaf have not been changed. The Forest Service, the States, and private owners are urged to cut and utilize as much diseased timber as possible during the current timber shortage. The diseased trees deteriorate rapidly in the stands after death.

Dutch elm disease, phloem necrosis, and other elm diseases: Stocks of American elm seedlings carefully selected for possible resistance to Dutch elm disease have been maintained in our nursery at Morristown, New Jersey. Seedlings and hybrids that have resisted the disease in

inoculation tests are being propagated, but sufficient stock has not yet been obtained to permit release of the material. Stock of the disease-resistant European elm, Christine Buisman, is ready for release this year to arboretums and the nursery industry.

Field plot studies to determine whether Dutch elm disease can be controlled by sanitation of local areas are being continued in New Jersey in cooperation with the Bureau of Entomology and Plant Quarantine and with State authorities.

Phloem necrosis of elm, a highly infectious virus disease, continued to spread and kill large numbers of elms in the Ohio and the Mississippi River Valleys. Work has begun in the newly invaded Missouri-Kansas area with headquarters at the University of Missouri for work on the disease in the area west of the Mississippi. Attempts to reduce spread through control of insect vectors by spraying are in progress. Selection of disease-resistant stock has been continued at the Columbus, Ohio field station with very encouraging results. Some of the more promising stocks will be sent to Kansas City in the spring of 1946 for testing in that area.

Disease-resistant chestnuts: Work has been continued on the selection and hybridization of Oriental chestnuts for the purpose of securing high-quality trees resistant to chestnut blight. A serious root rot of American chestnut greatly reduced the stand of this species in the southern States. Researches have shown that the Asiatic selections resistant to chestnut blight are also resistant to this root disease. Tests on resistance of hybrids between the Asiatic chestnuts and the American chestnuts to both of these diseases are in progress. In the testing of the different introductions of chestnuts from Asia, one strain from the general vicinity of Nanking is showing up especially well. Some of the best of the trees planted out 18 years ago are tall enough to give every indication that they will make small telephone poles. The nuts of this strain are of good quality. Many additional strains need widespread testing to determine which ones are best suited for different parts of the country.

Current disease problems in National Forests and National Parks: Wartime consumption of lumber stimulated timber cutting on National Forests and new pathological problems have arisen demanding consideration. In the West assistance has been given the Forest Service in establishing marking principles and in modifying requirements for disposal of logging slash and defective trees in a new logging operation in stands of California red fir and white fir on the Shasta National Forest. In another forest increased cutting of ponderosa pine was advised to prevent serious losses from crown rust which kills mature trees. This disease was found at new locations in Arizona and New Mexico.

Experimental mistletoe control plots were inspected on the La Sal National Forest in Utah, the Coconino National Forest in Arizona, and the Deschutes National Forest in Oregon. On the La Sal Forest mistletoe was removed from test areas in 1930 and again in 1935. Control of

the pest on ponderosa pine by these operations has been very effective. Previously, practically nothing was known about the control of dwarf mistletoe and these results are of particular value in planning further operations.

When fire sweeps through a coniferous stand, problems in management of the damaged timber arise instantly. Determination must be made of how badly the stand has been damaged, which trees have been killed and must be salvaged, which can be left, and whether selective logging can be practiced. Study of fire-damaged stands revealed that the degree of damage to the lower trunk is of greater value than the extent of scorched foliage in determining probable tree survival, and deserves more attention by foresters marking trees for salvage.

In the East some strains of otherwise desirable hybrid poplars were found to be very susceptible to a killing canker disease. The danger of use of these susceptible strains alone in establishing poplar plantations for pulpwood or other purposes has been pointed out.

A fungus called Fomes annosus that infects pine roots without indications of its presence on the surface, has been found to be a factor in the dying of pines in large areas in parts of the West. The fungus spreads through the roots from tree to tree and is able to attack pines of all sizes and ages. Trees dying from it are normally invaded by beetles, after which there is usually no way of determining the primary cause of death of the tree without an examination of the roots. On this account, survey is difficult and estimates of the prevalance of this root Fomes and the amount of timber killed by it have not yet been obtained. Killing appears to be confined largely to forests on loose soils in the drier parts of the pine range.

A potentially dangerous new pine canker was recently discovered in the South, and has been found predominately on Virginia pine but also on other hard pines in the vicinity of Asheville, North Carolina. The canker, caused by a fungus of the genus Fusarium, commonly attacks the central leader branch but side branches are also invaded and killed. The disease is being called resin canker because of the large amount of pitch flow and pitch soaking that accompanies invasion of the wood by the parasite. Where the disease originated and its possible present distribution in the United States are not known.

Natural decay resistance of different woods: Following the studies on U. S. black locust and oak species previously reported, a special series of accelerated laboratory decay tests on tropical American woods was completed. Nearly 5,000 specimens from trees of 39 species supplied by Forest Service survey parties were tested by inoculation with various decay fungi, together with 600 specimens from principal U. S. species for comparison. From the same sources 2,000 small stakes had been set in soil at points in Central America and the United States, on part of which final examinations have been made. Striking differences were found between different species; oak from the remarkable stands discovered by the Forest Service in Costa Rica proved more resistant than U. S. White Oak. The heartwood of some of the tropical species was

found to contain chemicals highly toxic to fungi. In most cases the outer heartwood proved more resistant than the inner. Even the sapwood of many of the tropical species proved surprisingly resistant to the brown-rot fungi important in the U. S., but were susceptible to one of the white rots, indicating need for tests with others of the white-rot fungi. The results to date are being summarized.

Discolorations evaluated in aircraft lumber species: With the continued demand for high grade wood for certain types of aircraft, the studies that had resulted previously in better understanding of the significance of defects and discolorations in plywood made from eastern hardwoods was extended to lumber of Sitka spruce, western hemlock. and Noble fir. It was found that several of the commoner discolorations do not indicate decay or significant loss in strength and hence lumber containing such discolorations need not be rejected because of them. A new question arose in connection with the use of birch. A stain of different type from that previously studied, complicated inspection at two of the propellor factories. This was found due to infection with a fungus, and therefore to indicate that the lumber had not been properly dried. However, the wood containing this strain fungus was shown to retain normal strength except where incipient infection with decay fungi has occurred with it.

Protection of green lumber: Much construction lumber is being shipped without seasoning, sometimes to destinations requiring months in transit. This often results in inconspicuous infections by decay fungi, potentially much more important than the staining fungi against which previous experiments were mainly directed. Incipient decay which has not seriously weakened the wood by the time it reaches destination, can continue to develop and damage structures built with the lumber in situations where it can not dry out promptly. Special tests have been partly completed with green lumber bulk-piled after various chemical dipping treatments. The chemicals developed for stain control have been found quite as effective against decay, even in lumber kept moist in solid piles for many months of moist storage. The use of borax to replace part of the scarcer chemicals in the dipping solutions, previously found successful in stain control, appears equally successful in hindering decay. Steps are being taken to determine quantitatively how much loss in strength results from different lengths of moist storage and how long the protection by the treatments can be expected to last.

In special tests made on hickory and dogwood used for textile picker sticks and shuttle blocks, the chemical dips previously developed for other species proved effective and harmless. The information was supplied to the interested agencies and will be published.

Protection of wooden containers: Mold growth on nailed wooden boxes is objectionable because it tends to obscure labels and greatly detracts from the appearance of the containers. A simple dipping treatment has been found to control molding of boxes nearly as well as the more elaborate and expensive treatments formerly employed, and with less danger of skin irritation to workmen. The treating bath consists of a water solution of sodium pentachlorphenate and commercial borax.

(e) Soils, Fertilizers, and Irrigation

Appropriation Act, 1946		$913,000
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+105,000
Total anticipated available, 1946		1,018,000
Budget estimate, 1947		1,505,000
Change for 1947:		
Overtime decrease ..	-17,700	
Increase	+504,700	
		+487,000

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Soil management and fertilization for crop production	$139,315	$157,200	$157,710	+$510 (1)
2. Irrigation practice, drainage, and salinity control	123,050	272,950	273,600	+650 (1)
3. Dry-land management	192,490	210,190	210,730	+540 (1)
4. Soil classification				(+1,890 (1)
for crop production ..	138,750	166,750	568,640	(+220,000 (2)
				(+180,000 (3)
5. Fertilizer materials and improvement	170,320	193,210	194,320	+1,110 (1)
6. Evaluation and management of soils for agricultural use in Alaska	- -	- -	50,000	+50,000 (4)
7. Repair and reconditioning of physical facilities at field stations	- -	- -	50,000	+50,000 (5)
8. Overtime pay	116,736	17,700	- -	-17,700
Covered into Treasury as miscellaneous receipts, Public Law 529	85	- -	- -	- -
Unobligated balance	16,678	- -	- -	- -
Total available	897,424	1,018,000	1,505,000	+487,000
Anticipated supplemental	- -	-105,000	- -	
Total estimate or appropriation (1945 adjusted for comparability)	897,424	913,000	1,505,000	

INCREASES OR DECREASES

The net increase of $487,000 for 1947 consists of the $17,700 decrease for overtime, and the following:

(1) Increases totaling $4,700, distributed by projects as indicated on the Project Statement, for placing on a full-year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(2) An increase of $220,000 under Project 4 for soil classification and mapping in the national cooperative soil survey program:

Objective: To investigate and classify the farm soils of the United States to determine their use for specific crops under defined management practices in terms of yield and maintained productivity; and to plot the soil on detailed soil maps so that the results of research and experience on each soil type may be applied by the individual farmer to his own land.

The Problem and its Significance: Great numbers of farmers follow cropping systems and methods of soil management which lead to progressively lower yields and soil depletion. Soils vary from farm to farm, and recommendations for their use and management must be in specific terms for each soil type. A large body of scientific knowledge exists upon which to base specific recommendations for improved crop and soil management, yet this knowledge cannot be applied effectively to individual farms without a knowledge of the kinds of soil on each farm. Adequate soil maps are essential, therefore, to realize completely the ultimate objective of crop and soil research carried on by the Department and State Agricultural Experiment Stations at a cost of many millions of dollars. Less than half of the rural lands in the United States now have adequate soil maps. It is imperative, therefore that the balance be mapped as rapidly as possible so that all farmers may utilize research information most effectively.

The Bureau has the responsibility for leadership in the national soil survey program and to correlate all soil classification and naming throughout the country. The added support is necessary to meet this responsibility effectively through cooperation with the State Agricultural Experiment Stations and Federal agencies dealing with agricultural land, especially the Soil Conservation Service.

The critically important differences occurring among soils in every area modify the results of fertilization, liming, tillage, drainage, irrigation, erosion control, and other cultural practices on almost every farm. They affect the performance of various crops and crop varieties and the occurrence of plant diseases. All research dealing with soils and soil-plant relationships must take definite soil types into account and be interpreted on that basis. The results of such research then may be applied to areas known to have soils like those on which the research was conducted. Soil classification and soil maps become the medium for

applying these findings on individual farms. They are an essential part of the soil and crop research program.

In order to insure the complete coordination of the Bureau's plant and soil research in all areas it is highly important that Bureau personnel participate in the field work of the survey in each State and in its interpretation. This would insure that the soil survey as a summation of all research and experience on the soil types involved will be a sound base for use by the Extension Service and other agencies in farm programs.

Plan of Work: Survey activities are conducted in cooperation with the State Agricultural Experiment Stations, the Soil Conservation Service and other interested agencies in order to maintain accuracy of standards and definition and to prepare detailed soil maps first for areas where most needed. The order in which areas are taken up will be determined by agreement as to the relative urgency of the adjustment problems. All interested agencies contribute to developing the plan of work for each survey according to the character of the area and the primary function of completed maps. The supervisory scientists of the Bureau have final responsibility for establishing the soil classification and for insuring uniformity of name and definition for the soil types according to the national system of soil classification. The program would permit the Bureau to cooperate in the field surveys in about 35 States.

(3) An increase of $180,000 under Project 4 for the compilation of soil maps and the preparation of soil maps and reports for publication for which field work is completed:

The Problem and its Significance: During several years previous to the war, contributions of the State Agricultural Experiment Stations and other interested agencies to the national cooperative soil survey program increased rapidly in relation to the facilities of the Bureau for compiling and drafting the maps for publication. During the war the problem was further aggravated by the difficulty of obtaining skilled draftsmen. As a result, a backlog of some 70 vitally needed soil surveys have accumulated that should be placed in form for general use as rapidly as possible.

Soil maps, together with the descriptions and interpretations of the soil types shown on the map, are critically needed to assist farmers in making necessary adjustments in their farming systems. The backlog of some 70 soil surveys for which the field work has been completed but which are unpublished represent a large investment of public funds the benefits of which can only be partially realized until the maps and reports are published and made generally available. Important use is made of the completed field work by county agents and other agricultural technicians with photographic copies of the field sheets but such use is incomplete and is limited to a few individuals. The early publication of these important surveys would be an important contribution to adjustments in farm cropping and soil conservation programs.

Careful estimates have been made of the total amount of work required to complete this backlog of 70 surveys, including the compilation and drafting of the soil maps and the necessary typing and editing of the reports that accompany them. It is proposed to do the job in 2 years.

(4) An increase of $50,000 under Project 6 to determine the character, crop adaptability, management requirements, and location of the principal soil types suitable for agricultural use near existing proposed rural or urban settlements in Alaska:

Objective: To develop basic information regarding crop adaptability, yields, and management requirements for the principal soil types, and soil maps showing their location, in order to give recommendations to established farmers and prospective settlers as to the suitability of specific tracts of land for agricultural use and as to appropriate cropping systems and soil management.

The Problem and its Significance: The agricultural potentialities within Alaska are of greatly increased concern because of the development of other industries and especially of communication centers in the Territory. Local sources of food are urgently needed and many people are seeking opportunity as farmers in Alaska. Yet the amount of soil suitable for farming is limited and much of it is intermingled with land not suitable. Further because of the short growing season and very long summer days, cropping systems and soil management methods will be required different from those followed in the United States. Experience has already demonstrated that economical farming for local markets can be carried out on some of the soils with proper management. But unless settlers avoid the unsuitable land and adopt soil management practices adapted to the special soil conditions in Alaska, failures are inevitable--failures that will result in severe losses to individuals and communities and in the creation of serious social problems.

With accurate soil maps of areas of prospective settlement and definite recommendations for the use and management of the specific soil types as developed by research and the analysis of experience to date, such failures may be avoided and orderly settlement expected.

Plan of Work: The investigations would be conducted in cooperation with the Alaska Agricultural Experiment Station. The principal types of soil to be found in settled areas, and in other areas of agricultural promise near rural or urban settlements, would be examined to determine their character, crop adaptability, management requirements, and extent. The work would be initiated in two important areas the first year.

Generalized soil maps showing the extent and distribution of soil types would be prepared for the regions of agricultural promise, and detailed soil maps of experimental areas and, as rapidly as possible, of agricultural and potential agricultural communities. Growing crops and grasses would be studied in relation to soil conditions, and samples of the soils would be collected and analyzed, along with enough samples of vegetation, to establish the principal chemical relations that affect the nutritive value.

Field experiments would be established on several of the principal soil types to determine their responses to the use of fertilizers, lime, and other approved management practices. This work would be done in conjunction with the testing of cereal and forage crops in the field.

At the Experiment Station, a laboratory would be set up and equipped for carrying out the routine physical and chemical analyses necessary in conducting field investigations and interpreting the soil classification and results of plot experiments.

From the observations made in the field, from the results of the preliminary research carried on cooperatively with the agronomists, and from the analysis of experience on existing farms, the crop adaptability, yields, and management requirements for each soil type would be developed in definite form for use in making recommendations to established farmers and prospective settlers regarding the suitability of specific lands for use and as to appropriate crop rotations and systems of soil management.

The field investigations would be carried out and expressed in terms of the international methods and nomenclature so that full advantage may be taken of experience obtained in northern Europe, northern Asia, and northern Canada. Toward this end, arrangements for cooperation with Canadian soil scientists would be made, and perhaps later, with those of the Soviet Union.

(5) An increase of $50,000 (Project 7, non-recurring) for repair and reconditioning of physical facilities at field stations, for which an overall justification statement has been included previously in these Explanatory Notes under the appropriation "Field Crops:"

This increase is requested to paint and repair laboratory and office buildings, implement sheds, seed storage houses and other services buildings; repair fences, irrigation and drainage installations, roads, water supply and sewage disposal systems; and is essential to reduce the backlog of repair and reconditioning work which accumulated during the war.

The increase is estimated by locations as follows:

Bard, California	$5,000	Lawton, Oklahoma	$2,500
Akron, Colorado	3,000	Woodward, Oklahoma	6,000
Huntley, Montana	4,500	Hermiston, Oregon	3,000
Mitchell, Nebraska	4,000	Newell, South Dakota	4,500
Fallon, Nevada	3,700	Big Spring, Texas	2,000
Tucumcari, New Mexico	2,000	Dalhart, Texas	2,000
Mandan, North Dakota	6,800	Sheridan, Wyoming	1,000
			50,000

WORK UNDER THIS APPROPRIATION

Objective: The broad objective of the research program on soils, fertilizers, and irrigation is to advance public and farm welfare through developing information, methods, and materials to: (1) maintain and rebuild the nation's vital soil resources; (2) maintain and increase fertility while producing crops on the most economical sustained basis; (3) serve in helping to effect adjustments in land use to meet changes in national requirements; (4) aid in insuring a more stabilized and profitable agriculture in dry-land and irrigated regions; and (5) increase farm income to encourage and support a high standard of living. More specific objectives are as follows:

(a) To develop soil-management methods, including fertilization, liming, crop rotations, tillage practices, and other means of improving soils to maintain maximum economical production on a permanent basis.

(b) To develop improved soil-management and crop-production practices that will make possible the most efficient use of limited rainfall on different soil types in the Great Plains and other semiarid regions.

(c) To devise effective irrigation and drainage methods and practices to maintain production, and determine corrective measures for injurious salt concentrations in soils and in irrigation and drainage waters.

(d) To classify soils in a national system, determining their potential productivity under adapted cropping and improved management, and mapping their distribution for use in applying improved soil management and land use on individual farms.

(e) To develop improved and cheaper fertilizers and more effective methods of use.

The Problem and its Significance: The basic problem in soil management is to maintain and improve soil fertility under cropping systems that are profitable and permanent for the wide range of soil types and climatic conditions in the United States. Abundant evidence points to widespread deterioration in the inherent productivity of American soils. This deterioration has reduced the beneficial effects on crop yields that should have accrued from great improvement in crop varieties, the use of fertilizers, land drainage and more efficient cultural practices. This deterioration is occurring even on the best level lands where erosion is insignificant, although, of course, erosion has speeded the process greatly in many areas. Often erosion does not begin until the protective vegetative cover has been starved out by soil depletion.

Results of studies for a 31-year period by the Ohio Agricultural Experiment Station on Wooster silt loam soil show that a good management system yielded annual net returns of $30 per acre and a poor system only $7 per acre. Furthermore, soil productivity in the poor system is

still declining at a rate estimated at 10 percent in 10 years, whereas soil productivity in the good system is being steadily increased. This illustrates what is happening to soils elsewhere in the nation under poor or indifferent soil management, and the possibilities for developing effective management practices. Proved methods of good soil management have been worked out for relatively few soils, and in most areas information is needed on the effects of present practices and what changes should be made.

War and postwar conditions have produced many problems relating to fertilizers and their use. Imports of certain fertilizer materials have been stopped. In the face of a world shortage of fertilizers and an increased world demand, we are exporting more than normal amounts. The war produced important changes in fertilizer technology as a result of the introduction of new fertilizer materials and caused a great increase in capacity for nitrogen fixation and sulfuric acid production. One of the important problems is the effective incorporation in our civilian economy of war plants suitable for the production of fertilizer materials. This involves integration with the conservation of our fertilizer mineral resources and a sound soil management and use program. The importance of the fertilizer and lime problem was recognized by the Department in the formation of a Departmental Committee on National Fertilizer and Lime Policy, which formulated a publication "A National Policy on Lime and Fertilizer Materials."

Problems which require a concerted attack include, among others: Soil-management practices to improve soils and maintain productivity in all parts of the country, involving rotations, cover crops, green manures, and the use of soil amendments and fertilizers as related to different crops grown on different soil types; soil-fertilizer relationships, including methods to increase the availability of phosphate and potash fertilizers in certain soils; the development and maintenance of desirable soil tilth so essential in economic crop production and in the maximum conservation of soils; soil-management and fertilizer practices necessary to produce profitable crops under irrigation and on dry lands on a sustained basis; development of new fertilizer materials, fertilizer combinations, methods of manufacture, and testing the properties and values of fertilizers in order to reduce farm costs of fertilizers; classification and mapping of soils to provide information on the soils of individual farms which can be used to translate soil-management practices, fertilizer needs, and crop adaptation into the operations of each farm.

General Plan: Investigations relating to soil management and fertilization for crop production are being closely correlated with the work of State agricultural experiment stations. This is also true of the work with fertilizers, where, as a new fertilizer is developed, it is tested at several State stations, as well as at the Bureau's station at Beltsville, Maryland.

Cooperative dry-land management investigations are conducted at: (a) field stations maintained by this Bureau at Akron, Colorado; Huntley, Montana; Tucumcari, New Mexico; Mandan, North Dakota; Lawton and Woodward, Oklahoma; Newell, South Dakota; Big Spring and Dalhart,

Texas; and Sheridan, Wyoming; and (b) at substations maintained by the respective States at Colby, Garden City, and Hays, Kansas; Havre and Moccasin, Montana; North Platte, Nebraska; Dickinson, North Dakota; Pendleton and Moro, Oregon; and Archer, Wyoming. At these stations facilities are provided also for work cooperative with various divisions of the Bureau, such as Fruit and Vegetable Crops and Diseases, Cereal Crops and Diseases, and Forage Crops and Diseases; with other agencies of the Department, such as the Soil Conservation Service; and with the State Agricultural experiment stations of the several States.

Irrigation-practice, drainage, and salinity-control investigations are conducted primarily at field stations, supplemented by necessary laboratory experiments. These field stations are located on Federal reclamation projects and the facilities available are used for cooperative investigations by other divisions of the Bureau of Plant Industry, Soils, and Agricultural Engineering, by the Bureaus of Animal and Dairy Industry, and by the several State experiment stations. The use of land and of irrigation water has been provided by the Bureau of Reclamation, and this agency also has contributed some buildings and special aid in land leveling and ditch construction. The field stations are located at Huntley, Montana; Newell, South Dakota; Scottsbluff, Nebraska; Fallon, Nevada; Bard, California; and Hermiston, Oregon. Cooperative investigations are conducted also at a State Branch Experiment Station at Prosser, Washington. Research covering field studies of crop adaptation, soil management, irrigation practices, soil-water relations, and plant disease and nematode control is being expanded in 1946 at Bard, California, Hermiston, Oregon, and Prosser, Washington; and initiated at Yuma, Arizona, to provide information needed in the development of the newly irrigated lands in the Lower Colorado and Columbia Basin areas.

Investigations on salt constituents of irrigation and drainage water involve cooperation with corporate irrigation districts and the Department of Interior's Bureau of Reclamation, Geological Survey, and Office of Indian Affairs. These agencies collect samples of irrigation and drainage waters at appropriate gaging stations where the volume of discharge is regularly measured. These water samples with the discharge data are sent to the laboratory at Riverside, California, where the water is analyzed and the quantities of salt constituent conveyed past each station are computed. Thus the annual input and output of dissolved salts (the annual salt balance) of an irrigated district is determined. If, in any districts, the salt balance is adverse, that is, if the salt input exceeds the output, remedial measures are indicated.

Fertilizer and lime investigations include studies on the production, technology, and efficiency of fertilizer and liming materials and mixed fertilizers. Rapid advances in technology of mixed fertilizers have introduced many problems and increased the volume of research directed to assist farmer cooperatives and other manufacturers of mixed fertilizers. Analytical procedures for fertilizer analysis and control receive continuing review and research.

Studies on domestic and world resources, production, trade, and consumption of fertilizers and liming materials including minor elements

are conducted in cooperation with State and Federal agencies. This includes studies in cooperation with other agencies of the factors influencing trends in fertilizer consumption in different parts of the country and the effect of fertilizer consumption on the maintenance of soil fertility.

Soil surveys are conducted cooperatively with appropriate State agencies, especially the State agricultural experiment stations, and with the Soil Conservation Service, the Tennessee Valley Authority, and other Federal agencies. In the fiscal year 1946, all field work on regular soil surveys is conducted by State soil survey organizations.

Scientists of the Bureau also cooperate with other public agencies in developing agricultural and land programs that involve needs for a knowledge of soil and for the interpretation of soil maps and other soil research. These cooperating agencies include the Bureau of Agricultural Economics, the Farm Credit Administration, the Soil Conservation Service, the Farm Security Administration, the Tennessee Valley Authority, the Forest Service, the Bureau of Reclamation, and the Bureau of Indian Affairs.

For effectiveness, soil-survey work is coordinated on a national basis so that similar soils are everywhere given the same names and descriptions in all States. At the same time, the State scientists contribute their detailed local experience. This cooperative basis makes it possible to have the benefits of both local and national experience and to develop a common nomenclature that fits the local conditions.

The Bureau not only sees that soil types are accurately and uniformly defined and mapped but also coordinates the results of plant and soil research with the findings regarding soil types and soil groups recognized in the system of classification. It is through the medium of soil classification and soil maps that much of the Bureau's work finds application to specific fields, farms, and rural communities.

Progress and Current Programs:

Soil Management and Fertilization for Crop Production:

Corn fertilization studies: A program of regional studies was inaugerated in 1944 aimed at raising the yield of feed crops in the South, and thereby removing one of the major impediments to increased livestock production. The work includes experiments to determine the potentialities for increasing the yield of corn under various soil conditions at eleven locations distributed in the Coastal Plain and Piedmont regions of North Carolina. In addition to the variation in soil conditions, the seasonal conditions in 1944 ranged from very dry to near optimum moisture. The results clearly indicated that corn yields can be increased far beyond the present levels by adequate fertilization combined with the use of adapted hybrids and closer planting.

The amount of nitrogen applied was the most important factor in all eleven experiments. The largest increase due to fertilization was from 19 to 107 bushels per acre and the lowest was from 21 to 53 bushels; the former under good moisture conditions and the latter under droughty conditions. The high yields were obtained in Hoke County on a sandy loam soil. Without nitrogen, 19 bushels of corn per acre were obtained; but with 120 pounds of nitrogen, 107 bushels total, or 88 bushels increased yield was obtained. Intermediate applications of nitrogen from 20 to 80 pounds per acre, gave corresponding yield increases. Throughout the range 1.4 pounds of nitrogen gave one bushel increase of corn.

Doubling the corn yield in North Carolina in the next ten years does not seem to be an unreasonable goal. An increase of 10 bushels per acre would make up the entire feed grain deficit of the State and doubling the yield (about 20 bushels increase) would be of untold value in developing the livestock industry of the State. The work was expanded to include similar experiments in South Carolina in 1945.

Depletion of soils in the Northern Great Plains: Recently completed studies of soils from the longtime crop rotation and cultural experiments at Mandan, North Dakota show that under the cropping systems generally followed in the area, these naturally fertile soils are being depleted at a rate that, if continued, may have serious consequences in reducing crop yields. The magnitude of the depletion is reflected by the changes in organic carbon and nitrogen contents of the soils. Continuous cropping of wheat, oats, barley and corn showed losses of carbon from 17 to 39.5 percent and of nitrogen from 15 to 37 percent. These losses were smaller in all cases than in those where continuous cropping alternated with fallow. With alternate fallow the losses of carbon varied from 27 to 44 percent and for nitrogen from 25 to 41 percent. A rotation of corn, wheat and oats without manure gave a carbon loss of 38.4 percent and nitrogen of 35 percent. With manure the loss in carbon was only 5 percent and for nitrogen there was an increase of 2 percent. Only where manure is used is no depletion of the soil evidenced.

Release of fixed phosphorus in soil: The fixation of phosphorus in acid soils has long been known to reduce greatly the recovery of applied phosphorus by crops. Experiments are continuing to determine the best rate of phosphorus application in relation to the amount of accumulated phosphorus in the soil which may be utilized in plant growth. A survey was made of the phosphorus fertility status of soils from commercial potato farms in Maine, Long Island, New Jersey, Maryland, and North Carolina. Samples of soil from these farms were analyzed for comparison of available phosphorus in the soils. Most of the soils samples from Long Island, New Jersey, and North Carolina contained very high amounts of available phosphorus, and those from Maryland and Maine, moderate to low amounts. The absorption capacities of Maine soils were found to be high but those of soils from other states were medium to low. The Coastal Plain soils, which are generally sandy, contained less than 7% clay and had a very low phosphorus fixing capacity. It was not unusual in this survey to find potato soils with relatively

high fixing capacity which had accumulated an excess of 1500 pounds per acre of phosphoric acid as a result of intensive use of commercial fertilizer extending over a number of years. With fuller knowledge of the rate at which fixed phosphorus in soils is released as plant food, more efficient utilization of fertilizer phosphorus will be possible, with resulting reduction in fertilizer expenditures by growers.

Irrigation Practice, Drainage, and Salinity Control:

Good soil management increases crop yields under irrigation: Abundant evidence points to the value of employing improved soil management practices to obtain higher crop yields under irrigation, and at the same time raise the level of soil fertility, increase the economy of crop production, and preserve the natural soil resources.

Average crop yields for an 18-year period of a "maximum production" experiment at the Huntley, Montana field station are more than 100 percent greater than the farm average on the project, and substantially higher in every case than selected rotations. The maximum production practices included the crop rotations, manure and fertilizer applications, tillage, cultivation, and other practices considered best for the region.

Control of salinity of irrigated soils: In order to maintain the productivity of irrigated soils it is essential to know the salinity trends in the soil as affected by salt content of water used and by irrigation and drainage practices. Varying quantities of soluble salts are carried by irrigation water into the soil. If the rate of removal in drainage water is not equal to the addition of soluble salts by irrigation water, an unfavorable salt balance results. In many instances this trend of alkali accumulation is slow and the effects at first will not be readily discernible in crop yields. When a serious alkali condition develops considerable difficulty is usually experienced in reclaiming the soil and restoring productivity.

The Bureau is currently engaged in following the salinity trends in soils of the irrigated areas as related to salinity in irrigation water, in soils, and in drainage water. An example of this work is a recent salt balance study of the Sunnyside Valley Irrigation District in California. The outputs of water and of soluble salts in drainage water were 41 and 185 percent respectively of the input during 1943, and 38 and 171 percent during 1944.

As indicated from these results the salt balance in this irrigation district is favorable. The management practices are removing in drainage water the dissolved salts faster than they are being deposited by the irrigation water. This is opposite from results previously obtained in the Imperial and Yuma Valleys, where heavy accumulations of salt were found to be taking place, information that formed the basis for extensive drainage undertakings. Such studies are instrumental in preventing development of alkali conditions in many irrigated areas.

Dry-land Management:

Farming system developed for Central Plains: As a result of experiments in crop rotation and cultural methods conducted at the Akron, Colo. Field Station since 1908, a farming system suited to the western part of the Central Plains has been developed in the form of a basic but flexible 4-year rotation. This rotation is (1) fallow; (2) winter wheat on fallow; (3) grain sorghums and beans in alternate strips on winter wheat stubble land; and (4) forage sorghums, grain sorghums, or proso millet on the sorghum land, and oats and barley on the bean land. A part of the sorghum in such a rotation may be replaced by corn, especially on the sandier soils, in which case spring-sown small grains could follow the corn.

This rotation utilizes the two most important crops of the section--winter wheat and sorghums; provides for the storage of water by fallowing; reduces chances of failure in any year by using crops that make their maximum demands for water at different seasons, and provides both money crops and feed crops for livestock. The type of agriculture best suited to the area appears to be livestock raising supplemented by cash crop production. Throughout the cropping system there is great need to be water conscious and to conserve in the soil as much as possible of the rainfall; but even where this is done, safety demands the accumulation of feed reserves during favorable periods for use in years of extreme drought and low production.

Investigations show place of crop residues in dry-farming: Tillage investigations at dry-land field stations have long included methods that (1) leave all the crop residues on the surface, (2) leave a portion of the residues on the surface, and (3) bury the residues by plowing. Annual results have sometimes varied considerably among these methods, but the average moisture storage and the average yields of crops from the three methods have been about the same, except for one location in the Columbia River Basin where lack of nitrogen was a controlling factor and crop residues on the surface depressed yields. Crop residues on the surface are, however, of value for controlling erosion by both wind and water. The results to date indicate that emphasis should be placed on their erosion preventing features, with special regard to the long-time effects of erosion, rather than on their effect on yield. Intensive investigations are being continued with implements that are designed to cultivate the soil and kill moisture consuming weeds with little disturbance of the stubble cover.

Soil Classification for Crop Production:

Making and publishing soil maps: Although field scientists normally engaged in making new soil maps have been occupied with studies of the soil requirements and potential distribution of special war crops and food crops, substantial progress has been made in developing vitally needed soil maps by personnel in cooperating State organizations. About 1,085,000 acres were examined and mapped in detail by cooperating scientists in the States. The publication of reports and maps was greatly curtailed by the War during the past year. Five printed reports with colored maps were issued during the year, bringing the total number

of published surveys to 1,540. The new reports were for Macon County, Ala.; Tishomingo County, Miss.; the Big Horn Valley area, Mont.; Huntingdon County, Pa.; and Kittitas County, Wash.

Soil data help Army and Navy: Continued and increased assistance, based upon the large collection of domestic and foreign soil samples and the personal knowledge of the scientists, was given the past year to the Army, Navy, and other war agencies regarding soil conditions in this and other countries in relation to food production, airport construction, trafficability for tanks and other military vehicles, camouflage, character of terrain, and associated problems concerned with the occupation of foreign areas.

Fertilizer Materials and Improvement:

Defluorinated phosphate rock: Defluorinated phosphate rock is being manufactured commercially for the first time by several companies and the Tennessee Valley Authority. Defluorinated rock is the outcome of work carried on by the Bureau over a number of years. Heating phosphate rock with silica in the presence of steam at temperatures of 1400 to 1600°C. volatilizes the fluorine and converts the phosphorus into a readily available form. The product is suitable for use as a fertilizer, and is important as a source of mineral phosphate low in fluorine for animal feeds.

Heating in fertilizer mixtures: Investigations of heating in fertilizer mixtures have definitely established that spontaneous combustion is possible in certain mixtures containing ammonium nitrate and organic material. Oxidizing reactions initiated by the presence or formation of free acid have been found responsible for the heating. The reactions may be arrested by the addition of ammonia or other neutralizing agents in proper amounts. The principle factors involved and the limitations on conditions have been determined for many mixtures. An article has been published on the possibility of spontaneous combustion and its prevention. A Department circular has been issued on the explosibility and fire hazard of ammonium nitrate, pointing out the possible dangers and making recommendations for the safe handling of commercial ammonium nitrate as a fertilizer.

Factors influencing fertilizer consumption: An intensive study was made of data collected on the consumption of fertilizers and a critical examination made of the relationship of fertilizer consumption to farm income and other factors likely to exert appreciable influence on fertilizer use. It was found that income from marketing of crops plus Government payments is more highly correlated with expenditures for fertilizers than any of the other factors examined. Ninety-three percent of all fluctuations in expenditures for fertilizers between 1911 and 1943 were accompanied by corresponding fluctuations in three factors: (1) the cash income from marketing crops plus Government payments the previous year (2) the income in the year of fertilizer purchase (3) the proportion of the previous year's income remaining after expenses of production are deducted. Fifty-six percent of deviations of fertilizer expenditures from the average are accounted for by similar fluctuations

in income from crops plus Government payments; twenty-eight percent by fluctuations in the same year's income; and nine percent by changes in the proportion of the previous year's income remaining after deducting production expenses. Eleven percent are unexplained and are probably due to other factors. The previous year's income has less than average influence in Pennsylvania, more in South Carolina, and is of little importance in the Central States.

Example of peacetime research utilized in war: As a result of research started some years before the war, a method for surface area measurements, developed for use in measuring the amount of surface in soils by the absorption of gases at low temperatures, has proven to be of great value in the petroleum industry for the development of cracking catalysts; and in the paint industry for increasing the covering powers of pigments. The production of high octane gasoline during the war was greatly aided by the Bureau's work on the nature of clays and the measurement of surfaces of solids. Clays and related compounds are the only type of cracking catalysts now used for the production of high octane gasoline. The activities of these catalysts are strongly dependent upon the extent of their total surface area. Similar relations are fundamental for the use of catalysts in many chemical processes.

(Continued on next page)

(f) Agricultural Engineering

Appropriation Act, 1946	$445,500
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945	+46,000
Total anticipated available, 1946	491,500
Budget estimate, 1947	610,500
Change for 1947:	
Overtime decrease - 7,200	
Increase +126,200	+119,000

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Farm mechanical equipment	$160,290	$165,820	$240,830	(+$ 1,010 (1) (+ 74,000 (2)
2. Farm structures and related investigations	52,690	146,700	147,540	+ 840 (1)
3. Mechanical processing of farm products	191,200	139,920	140,470	+ 550 (1)
4. Utilization of electric power on farms	6,795	31,860	31,860	---
5. Investigations to develop agricultural engineering practices needed for agricultural development in Alaska	---	---	12,500	+12,500 (3)
6. Repair and reconditioning of physical facilities at field stations and laboratories	---	---	37,300	+37,300 (4)
7. Overtime pay	41,628	7,200	---	-7,200
Covered into Treasury as miscellaneous receipts, Public Law 529	72	---	---	---
Unobligated balance	8,857	---	---	---
Total available	461,532	491,500	610,500	+119,000
Anticipated supplemental	---	-46,000	----	
Total estimate or appropriation (1945 adjusted for comparability)	461,532	445,500	610,500	

INCREASES OR DECREASES

The net increase of $119,000 for 1947 consists of the $7,200 decrease for overtime, and the following:

(1) Increases totaling $2,400, distributed by projects as indicated above, for placing on a full-year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(2) An increase of $74,000 under Project 1 to develop adaptations of farm machines for multiple-use:

Objective: To study multiple-use of farm machines and to develop units that will enable a machine by certain changes to be used for two or more field operations; permit the farmer to have available machines or attachments which can be readily mounted and demounted from his tractor; and effect a standardization of wheel sizes and construction.

The Problem and its Significance: About $300,000,000 worth of farm machinery and equipment, exclusive of tractors, was bought by farmers in 1944. Most of this included individual machines for individual operations - each with a set of wheels, frame, and other parts which could serve in common for two or three other machines. The chassis of each machine weighs from 1/4 to 1/2 of the weight of the total machine. By providing a design for a multiple-use machine, sizable savings in the farmers' investment costs are possible. Storage space would be held to a minimum, as would the time and effort required to change from one tool to another.

Some multiple-use equipment is available, such as the tool bar to which may be attached middle busters, seeders, or cultivating shovels. Preliminary work on fertilizer placement by Bureau engineers formed the background for a three-in-one machine which forms the bed, plants the seed, and places the fertilizer at the proper location. Preliminary work on multiple-use machines for specialty crops such as sugar beets, peanuts, sweet potatoes, and sugar cane also has been undertaken by Bureau engineers. The peanut harvester is one development resulting from this work. This machine digs two rows of peanuts with vines attached, kicks them free of dirt, and throws them into a single windrow with the peanuts on the outside to facilitate curing.

Much work is still necessary to cover the whole field of farm machinery if the maximum benefit of the multiple-use principle is to be fully realized. It appears possible to devise a practicable combination implement whereby the soil can be aerated, inverted, reduced to a seed bed, and planted all in one operation, where soil and climatic conditions permit. Field ensilage harvesters, corn pickers, corn shellers, and shredders, grain combines and grass harvesters should be adapted for multiple-uses. Opportunity exists for developing combination cotton machines, such as choppers and cultivators; and combination portable driers for drying hay, wheat, corn, rice, and other crops.

Many tractor mounted machines require excessive time to mount and dismount. These include row-crop cultivators, corn pickers, and planters. Research is needed to develop designs which reduce the time and labor to make these changes.

Standardized wheel sizes would increase the possibilities of developing multiple-use machines. There are over 500 wheel sizes for drawn farm machines, and standardization even to 100 sizes would effect a considerable reduction in production costs to be passed on to the farmer in lower-cost machines. By using drop axles or other construction, the size of hay rake, hay loader, cultivator and many other farm machinery wheels could be standardized and designed for using rubber tires, which would enable the farmer to reduce his investment in rubber tires. He could change tires from one machine to another as needed and possibly make use of old truck tires.

Greater use will be made of farm machinery in the post-war period, and research to develop multiple-use machines can contribute greatly to increased efficiency and reduced labor costs in performing farm operations.

Plan of Work: The work would be carried on in cooperation with the Soil Conservation Service and the State Agricultural Experiment Stations of California, Georgia, Indiana, Kansas, and Texas. Existing shops and facilities of the cooperating agencies would be used as far as possible. Critical construction studies would be made of important field machines and experimental combinations of multiple units worked out.

(3) An increase of $12,500 under Project 5 to develop and improve agricultural engineering practices in the production, processing and storage of farm products in Alaska:

Objective: To develop and adapt equipment and operating techniques for the production, processing and storage of farm products in Alaska.

The Problem and its Significance: Agricultural development of Alaska should emphasize the production of adequate food, feed, and livestock products for local consumption. Certain limited areas produce large yields of a variety of crops and some vegetables and small fruits can be grown abundantly. Dairying is practiced to a limited extent in some areas. At present, however, a large part of the food supply is imported and the need for providing additional supplies of home-grown food is urgent because of the increase in population that is expected in the near future.

The provision of adequate home-grown food supplies in Alaska will depend in large part upon the development of suitable equipment and facilities for the production, processing, and storage of farm products. The long cold winters and short growing seasons prevent

the direct application of the agricultural engineering practices used in the Continental United States. Long winters require storage of maximum amounts of feed, forage, and root crops for livestock, and of fruits and vegetables for home use or sale. Barns must provide large space for hay storage and large silos are needed for pea vines and other forage crops. Farm homes must be heated and ventilated adequately to maintain healthful living conditions during the long winter season. Heat and ventilation also are necessary for livestock buildings, particularly for dairy barns, to provide for maximum production. The soils of Alaska present a serious drainage problem and the perpetually frozen subsoil affects both farming operations and the construction of permanent farm buildings. The application of engineering science to these problems can be determined only by thorough and extended experimentation in the various agricultural areas of the Territory, which are quite dissimilar in climate, soils, and suitability for crop production.

Plan of Work: The initial year's work would cover the establishment of an engineer on a year-round basis in Alaska for work in cooperation with Alaskan agencies. This engineer should be particularly experienced in the storage of grains and vegetables and have knowledge of the problems of heating and ventilating and a broad general knowledge of the entire field of agricultural engineering research. Arriving in the summer, he would install in existing buildings recording instruments to give a continuous and accurate record of conditions, such as temperature and humidity, which affect the efficiency of different types of structures. Throughout the winter season he would be engaged in studying the behavior of the present installations, and by the return of warm weather would have a complete operating record of the functioning of the present facilities as well as of their effectiveness. He would then be in a position to design improved installations and to give attention to other pressing agricultural engineering problems. Due to the great difference in climatic conditions in the various agricultural areas, it would be necessary to conduct similar experimental work in several areas.

(4) An increase of $37,300 under Project 6 (non-recurring) for repair and reconditioning of physical facilities at field stations and laboratories, for which an over-all justification statement has been included previously in these Explanatory Notes under the appropriation "Field crops". The increase is estimated as follows:

Auburn, Alabama: Paint and repair laboratory building and shops, repair roads, and repair 9 experimental soil bins, each 250x20x3 feet, replacing rails and under drainage; repair storm water system and replace tile drains to prevent flooding in shop and garage area and in soil bin area.....	$30,000
Stoneville, Mississippi: Paint and repair buildings at the Cotton Ginning Laboratory.....	7,300
	37,300

WORK UNDER THIS APPROPRIATION

Objective: The broad objectives of agricultural engineering research are to increase efficiency in farming operations, reduce labor requirements, decrease the costs of production, improve the quality of farm products through the use of efficient machinery and methods in both production and such primary processing as may be done on farms and in cooperative enterprises, and develop safe storage facilities for field crops and vegetables. More detailed specific objectives are (1) to improve existing and to develop new types of farm machinery for producing and harvesting field and vegetable crops; (2) to provide for more economical and efficient placement and use of fertilizers; (3) to devise mechanical means for the control of insect pests and plant diseases; (4) to improve equipment and methods in the primary processing of cotton, flax, ramie and other field and livestock products; (5) to devise safe and economical storages for wheat, corn, potatoes and other products; (6) to design more effective farm buildings better meeting the functional requirements of livestock and the requirements of efficient chore operations; and (7) to devise and develop new uses for electricity on farms.

The Problem and its Significance: Agricultural engineering in its broad sense is the application of engineering principles to agriculture. Engineering principles, however, have not been applied to agriculture to the extent they have in industry. The opportunities are great. Improved farm equipment--the farmers' production tools--and improved farm buildings, where the meat and other animal food products are developed and partially processed, should increase the efficiency and economy of many farm operations and permit the farmer to enjoy, as the urban dweller does, the benefits of engineering progress.

Agricultural engineering research, in collaboration with soil and plant research, is directed toward the designing of more efficient farm implements for improving practices in crop production, harvesting, handling and storing. Contributions of agricultural engineering research of this type aided materially in the record production of farm crops during the last few years. The work done thus far indicates still greater possibilities of improving crop production at reduced costs by the further application of engineering principles. Similarly, agricultural engineering research, in collaboration with animal husbandry and dairy industry research, is directed toward the improvement of animal production practices. Farmers have been building, or are having built for them, animal shelters and other farm structures based on ideas and opinions conceived principally in urban construction. Little information is available on the fundamental requirements of housed animals; that is, the required amount of air, desired temperature, humidity, and freshness. These factors affect animal efficiency as they do that of humans. Unsatisfactory conditions in animal shelters are paid for in increased feed, reduced weight, or lowered milk production. Exact determination of these fundamental requirements will provide a basis for designing, constructing, and equipping farm buildings for efficient livestock production. Similar problems pertain to dwellings and their equipment as well as to farm building arrangement.

The war brought home to all farmers the necessity of mechanized production, the advisability of better coordination between his machinery, cropping program, livestock and building equipment and the advantages of new and improved tools and labor-saving devices. He has seen the advantages of safe storages for field crops and vegetables so that they can be held without loss and marketed in an orderly manner. Many new and small volume crops require the development of production and harvesting machinery and methods before their permanent and potential value can be ascertained.

The extension of rural power lines emphasizes the need for research to provide the farm electric user with profit-producing applications. These include applications in poultry and hog production, light for illumination and health, automatic grinders and feed processors, water heaters, devices to improve animal health, non-freezing water faucets, hay hoists, manure-handling equipment, and other devices to simplify work, reduce labor, and increase production.

General Plan: Work is conducted at the following three Government-owned laboratories: Auburn, Alabama, for research in farm machinery; Stoneville, Mississippi, for developing improved methods of ginning cotton; and Beltsville, Maryland, for fertilizer placement machinery. Other laboratories and machine shops are located in buildings owned by cooperators, including the Flax Processing Laboratory at Corvallis, Oregon; a project on mechanical control of insects and pests at Toledo, Ohio; a project on potato storage at Fort Collins, Colorado; a project on sweetpotato-production machinery at Ellisville, Mississippi; and studies of problems in the storage of wheat, corn, sorghum and Irish potatoes at Ames, Iowa. Almost the entire research program is carried on in cooperation with State and other agencies.

Progress and Current Programs:

Farm Mechanical Equipment:

Machinery for European corn borer control. From 91.5 percent to 97.3 percent control of European corn borer was obtained in cooperative tests on power sprayer application of insecticides on sweet corn in the Toledo, Ohio, area in 1944. Hydraulic spray applications, using a special solid-cone type nozzle developed on the project, resulted in 91.5 percent control in plants and 94.5 percent in ears at a working pressure of 150 pounds. Increasing the pressure to 200 pounds and using the same dosage gave still greater reduction in the borer population. Sweet corn not treated resulted in almost a total crop loss, while the treated corn gave very good yields.

Limited tests on an experimental duster developed on the project, using DDT dust, gave 95.1 percent control in ears compared to no treatment. The open-back type spreader nozzle, also developed on this project, was used on the duster in place of the conventional type with closed back. This gives uniform distribution across the fan-shaped dust pattern and does not clog. Tests made by varying the air volume delivery in the blower of this machine indicated that the air delivery of present commercial dusters should be increased for most efficient insect control.

Preliminary tests of airplane application of cube dust resulted in borer reductions in ears ranging from 82.3 percent to 89.0 percent. With aerial sprays of concentrated DDT solutions borer reductions in ears ranged from 65.4 percent to 92.6 percent. The material was applied from a series of nozzles supplied by a special boom mounted under the wings of the plane, and spread a swath some 60 feet wide.

Fertilizer placement tests continue to show greatly increased crop yields. During the 1944 season in western Washington side-placement of the fertilizer produced the highest yields of several crops with typical acre increases over the yields of other placements as follows: peas, 384 pounds more than application of the fertilizer in the furrow with the seed by means of conventional drills; bush beans, 3,694 pounds more than broadcasting the fertilizer; and sweet corn, 1,415 pounds more than broadcasting the fertilizer. The optimum distances of the fertilizer band from the seed differed as follows: for peas 0.5 inch to side and 1 inch below; for bush beans 1 inch to side and 2 inches below. Under-seed placements with a 3-inch distance between the seed and fertilizer increased the yield of canning beets 11,708 pounds per acre and spinach seed 321 pounds per acre.

Deep placement of the fertilizer on the bottom of each plow furrow for vegetable crops in several eastern areas has given satisfactory results, but only under certain conditions has the method been superior to the placement in a band about 4 inches below the soil surface at each side of the row. Average yields for 2-and 3-year periods show that side placement produced greater yields than did the plow sole method as follows: on the eastern shore of Virginia, 17 percent more size A potatoes and only slightly more tomatoes; in Maryland the same yield of tomatoes, larger yields of sweet corn, and definite indications of larger yields of cannery peas; in northwestern New York, 5 percent more sweet corn and approximately the same yield of cabbage. The average of comparable yields of tomatoes in western New York favored the plow sole method by 7 percent. A combination of the two methods was best in some cases. It is evident that the most effective method depends on the kind of crop, amount and kind of fertilizer, and soil and moisture conditions.

Peanut production equipment. Tests of the 1944 improved peanut sheller indicated a saving of 200 pounds per ton of seed peanuts costing $200.00 a ton. The loss of seed peanuts through cracking is less than 2.0 percent with this improved sheller, as compared to 3.5 percent to 4.0 percent with our former model and 10.0 percent to 20.0 percent with commercial shellers.

The use of two USDA two-row peanut digger-shakers in harvesting 400 acres proved both economical and effective. Less peanuts were knocked off the vines than with any other equipment used. Hand stackers could handle 25.0 percent to 30.0 more peanuts windrowed with these machines than with a commercial side-delivery rake due to the fact that the vines were not roped. An application for a public service patent for this machine is pending.

Tung nut huller improved. An improved field tung nut huller developed at the Auburn Laboratory effectively hulled field run nuts at the rate of three-fourths ton per hour. Few nuts were cracked and the losses of oil or oil bearing pieces of kernels are lower than for commercial hullers. One manufacturer in Florida has indicated his desire to build 20 machines this year modeled after the Auburn huller.

A sweetpotato vine harvester has been developed which cuts the vines free from the ground, picks them up and loads them into a trailing truck or wagon. Removal of the vines facilitates harvesting the sweetpotatoes, and the vines provide an excellent stock feed.

Sugar beet production machinery. Three different types of sugar beet harvesters were studied in the field and a number of changes made to improve their performance. A variety of planter tests were made in an effort to increase the stand resulting from the use of sheared seed.

Sugarcane production machinery. Since starting sugarcane production and harvesting machinery investigations on July 1, 1944, a continuous-type sugarcane loader has been designed. Such a machine can be operated by one man instead of six or seven normally required on the conventional loaders, thus providing for more efficient use of labor and equipment.

A crushing-roll attachment for a sugarcane stubble shaver was developed for the destruction of the cane borer in summer-planted sugarcane. The shaver cuts the stubble off just below the ground level, and the crushing roll attachment crushes the stubble and the contained borers. It is to be used in the spring before the cane borer emerges from its overwinter haven in the summer-planted cane. By destroying the borer in summer-planted cane, it is expected that cane borer infestation can be materially reduced.

Based on the field experience of the 1944 harvest season, individual experimental units of a cane harvester are in the process of development. These consist of a stalk cutter for cutting the stalks off close to the ground, a stripper for removing the leaves, and a topper for cutting off the tops. After units are devised they will be combined into a complete machine and field tested.

Farm Structures and Related Investigations:

Research aids farmers to save soft corn crop. Farmers' Bulletin 1976, Handling and Storing Soft Corn, was issued to help farmers avoid serious loss on the 1945 crop of corn, much of which is soft. The bulletin is based on cooperative research studies of this Bureau under this appropriation and the Special Research Fund, and the Iowa and Illinois Agricultural Experiment Stations. It presents specific recommendations for handling and storing corn containing different percentages of moisture. Special emphasis is laid on the importance of leaving soft corn in the field until reasonably dry, picking the driest parts of the fields first, and testing the moisture content before picking to make sure that corn is not cribbed while too wet. Emphasis also is placed

upon clean husking, sorting out of wet ears and use of efficient types of ventilators in cribs so that the corn can dry to less than 15 percent moisture before warm weather in the spring causes molding and heating. About 55,000 copies of the bulletin were distributed and in addition the information contained was widely used by State Extension Services, the Agricultural Adjustment Agency, farm magazines, newspapers, and the radio. Farmers followed the recommended program to a marked degree. In the central corn belt harvesting was delayed four to six weeks after the customary date, during which time the conditions of the corn improved greatly. For example, in Iowa the corn dried from a statewide average moisture content of more than 40 percent on October 1 to 25 percent on November 1. Also a large percentage of farmers this year are using crib ventilators and other practices recommended in the bulletin; some are experimenting with artificial drying. The Bureau is conducting tests of methods and equipment for this purpose.

An emergency grain bin of wire and roll roofing. In view of the large wheat crop and inadequate storage and transportation facilities in the Southwest this year, an emergency-type grain bin was built and tested experimentally at Ames, Iowa and Hutchinson, Kan. The cost is about five cents per bushel of capacity. Limited experience indicates that dry grain should keep satisfactorily in a well-constructed bin of this kind for at least a year, if the bin is fumigated when necessary. The bin has no provision for ventilation and is not suitable for storing moist grain. It is demountable and can be rebuilt after emptying if care is taken not to injure the material.

Thermostatically controlled blowers and dampers improve potato storage. Tests of ventilating potato storage houses with thermostatically controlled blowers or dampers show better control of temperature than with natural ventilation; in most cases sprouting was practically eliminated. An advantage over manually controlled gravity ventilation is that the automatic controls start the ventilation as soon as the outdoor air is cold enough for cooling and stop when the air is either too warm outside or too cold inside. Circulation of cooling air under the floor and around the sides of the bin instead of through the potatoes reduces shrinkage. Ventilation by electrically driven blowers has special advantage in large potato houses and in warm climates where a large circulation of air is needed during the short periods when outside air temperatures are favorable for cooling. Storage designs using this method of ventilation were prepared for use under semi-tropical conditions in South America, and by the Navy for short-time storage of potatoes at supply points in the Pacific area. A manuscript has been prepared for a farmers' bulletin on potato storage.

Improved air circulation system aids rapid cooling and uniform temperatures in apple storages. Circular 740, Cold Storage for Apples and Pears, now in the Government Printing Office, presents results of previous studies of refrigerated apple storage in the Wenatchee-Okanogan district of Washington. The tests showed a considerable advantage in having inlets and outlets for air circulation spaced as far apart as possible. The volume and velocity of air passing each package of fruit

is thus increased, which results in better cooling. Fewer air ducts and partitions are needed and cost of construction is therefore reduced. There is also an advantage in reversing the direction of air flow every few hours in order to maintain uniform temperatures through the storage room, thus avoiding chilling of the fruit near the air inlets and undesirably high temperature near the air outlets. A manuscript, "Coordinated Management for Harvesting, Storing and Marketing Northwest Apples," also based on the above studies, has been prepared in cooperation with the Farm Credit Administration.

Research begun on housing requirements of livestock. To meet immediate needs for information on which the building materials industry can base farm building designs for the major farming regions, Circular 722, Functional Requirements in Designing Dairy Barns and Circular 738, Functional Requirements in Designing Laying houses for Poultry, were issued. Much of the information in these circulars is based on the opinions of livestock men and building specialists at the State agricultural experiment stations, since there are no research data on many important points. To remedy this situation new studies are being undertaken, as follows:

In cooperation with the Bureau of Animal Industry a miniature poultry house in which temperature, relative humidity, air movement, light and other environmental factors can be closely controlled and the amounts of heat and moisture produced by the chickens accurately measured, is being built at the Agricultural Research Center, Beltsville, Maryland. This will permit determination of the conditions under which hens produce eggs most efficiently. Arrangements have been made with the Missouri Experiment Station for a cooperative study of the most efficient types of buildings for dairy cows, using a specially constructed barn in which temperature and other conditions can be closely controlled; and with the California Experiment Station on the shelter requirements of hogs in hot weather.

New study of corn and small grain storage in the Southeastern States. Arrangements have been made with the University of Georgia for studies of corn and grain storage with the expectation that these studies may later include the storage of sweetpotatoes, tobacco and other southern crops.

Mechanical Processing of Farm Products:

Improved scutching machine for fiber flax. A new type of scutching machine has been developed at the Flax Processing Laboratory at Corvallis, Oregon, which has extracted, under the best operating conditions, as much as 23 percent of fiber based on the dried weight of the retted straw. Present methods give an average yield of only 10 to 15 percent fiber. This machine not only extracts more fiber from the flax straw but the work is of such good quality that the grade of the fiber is increased. Tests in commercial mills show that this scutcher increased the yield of line fiber at least 5 percent. The same tests showed an increase in grade from 3X to 4X, which difference in grade gives a net increase to the farmer of about $30 per ton of

fiber. With a minimum of 3,000 tons of flax fiber being produced annually, this improvement has real significance to Oregon flax growers.

Cotton ginning investigations. Many special problems are being studied by the Cotton Ginning Laboratory at Stoneville, Mississippi. An outstanding example is the trouble caused by gin chokages in the arid regions of the West, resulting in damage to cotton fibers and reduction in ginning capacity. These chokages and damages have been traced to the presence of static electricity in the ginned lint. Numerous methods were tested in attempting to eliminate this difficulty. The most effective method is the use of a fine mist introduced into the ginning system both before and after the lint has been separated from the seeds. It has been found that the addition of small quantities of sulphonated oil will break the surface tension of water mist, thus reducing the volume of water required, spreading it much more uniformly through the air, and obtaining almost instantaneous damping of the lint. This treatment eliminates the static electricity and stops the chokages, and also facilitates the pressing of dry cottons which frequently are so spongy as to prevent the packaging of full weight bales. In addition, preliminary tests show a slight increase in both the grade index and staple length as compared to similar untreated cottons.

Special fiber investigations. When the war in the Pacific shut off our principal supply of Manila hemp for naval cordage, sansevieria fiber was recognized as probably the best substitute. Sansevieria is the only hard fiber which will grow in the continental United States; however, no equipment had been developed which would properly decorticate it. An experimental laboratory was established at Bohnton, Florida, to study the mechanical problems involved in producing this fiber in this country. A successful decorticator has been perfected and it now seems that the production of this fiber may develop into a peacetime industry. At least it has been demonstrated that such an industry would be of value in the case of another war. It has been demonstrated that the sansevieria decorticating machine also will process ramie, roselle, and similar fibers which are used in this country although obtained from foreign sources. Efforts are being centered on the complete mechanization of all operations in harvesting and processing these fibers so that they can be profitably grown in the United States.

Utilization of Electric Power on Farms:

Cooperative work with the Virginia Polytechnic Institute is under way on barn drying of hay. A slatted-type false floor for the mow was devised which gives promise of better equalizing the air distribution throughout the hay than is possible with the conventional duct systems as now developed. Preliminary tests in drying peanut vines with peanuts attached indicate that it may be practicable to mow-dry and eliminate the difficulties often experienced with field curing, the method commonly followed.

Cooperative work with the North Carolina State College on the flue curing of tobacco was initiated the beginning of the current fiscal year. Preliminary investigations of air distribution in curing barns showed a wide range of temperatures and relative humidities, conditions which do not result in a uniform product. In many barns an open flame supplies the heat and there are no stacks, which means that the fumes and heated air must escape through openings and in the upper ventilator without contacting the tobacco. This causes a large loss in and unequal distribution of heat, and introduces a fire hazard. Many barns with their entire tobacco charge were burned down the past season.

Wood, coal, and oil are used as fuels, and flue designs to efficiently use them are essential for efficient operation. Installation of electrically driven blowers and electric controls as well as motor drives for stokers using wood and coal are needed.

(Continued on next page).

(g) National Arboretum

Appropriation Act, 1946		$26,800
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+4,800
Total anticipated available, 1946		31,600
Budget estimate, 1947		31,000
Change for 1947:		
Overtime decrease	-700	
Increase	+100	
		- 600

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. National Arboretum: Maintenance and operation of Arboretum	$26,539	$30,900	$31,000	+$100
2. Overtime pay	4,320	700	---	- 700
Covered into Treasury as miscellaneous receipts, Public Law 529	1	---	---	---
Unobligated balance	640	---	---	---
Total available	31,500	31,600	31,000	- 600 (1)
Anticipated supplemental	---	-4,800	---	
Total estimate or appropriation	31,500	26,800	31,000	

INCREASES OR DECREASES

(1) The net decrease of $600 for 1947 consists of the $700 decrease for overtime, and an increase of $100 for placing on a full-year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

The National Arboretum was established pursuant to the Act of March 4, 1927 (Public No. 799, 69th Congress), and the first appropriation for development and maintenance work was made for the fiscal year 1931. At the time the United States entered the war, development of permanent plantings at the National Arboretum was about 15 percent complete. During the war, the work was placed on a maintenance basis and the estimate of $31,000 for the fiscal year 1947 would provide for continuing the work on that basis.

Plans for renewal of development operations are now being considered by the Department and the Advisory Council for the Arboretum, and it is hoped that by the time the Budget estimates for the fiscal year 1948 are considered, or perhaps earlier, proposed plans for future development of

the Arboretum can be presented to the Congress for consideration. An immediate problem, however, is the necessity for moving some planting stock from nurseries at the Arboretum into permanent positions. Otherwise this stock will be lost, and many of the plants cannot be replaced. It may, therefore, be necessary later to propose an amendment to the 1947 estimates to provide for transplanting this nursery stock.

CHANGE IN LANGUAGE

The estimates propose the following changes in the language of this item (new language underscored, deleted matter enclosed with brackets):

> "***, including travel expenses of the advisory [counsel] council, [$26,800] $31,000, of which not to exceed $2,500 may be expended for employment pursuant to the second sentence of section 706(a) of the [Act of September 21, 1944] Department of Agriculture Organic Act of 1944 ([Public Law 425] 5 U.S.C.574).

The first change involves language which, using the proper word "council", has been carried in the annual appropriation act for a number of years. The change to the word "counsel" occurred inadvertently in the process of printing the 1946 Appropriation Act. It is desired to restore the correct word.

The second change merely revises the reference to authorizing law for the subject-matter involved without changing the authority carried in the appropriation act.

(Continued on next page)

WORK UNDER THIS APPROPRIATION

The National Arboretum is located in the District of Columbia bounded approximately by M and R Streets, N. E., Bladensburg Road, and the Anacostia River. An advisory council, appointed by the Secretary of Agriculture in accordance with the Act of March 4, 1927 (20 U. S. C. 191-194), assists in planning the development of the Arboretum. Plant collections generally are established in nurseries at the Arboretum prior to being placed in permanent plantings. Plant materials are obtained by purchase, gift, and by transfer from the bureau's Division of Plant Exploration and Introduction, a source of exotic plants from foreign countries.

The essential purpose of the Arboretum is the development of a living collection of all woody plants that can be grown in this area to serve as a source of plant materials and educational information concerning plant life for students and scientists throughout the country. The establishment at the Arboretum of a great storehouse of plant materials from all corners of the world would provide opportunity to breeders of trees, shrubs, and flowers to cross native species with those from foreign lands for the development of improved strains adapted for special purposes such as for city parks, forests, boulevards, and streets.

In order to be most useful for purposes of research and education, plans for development of the Arboretum include: (a) taking the fullest possible advantage of all environmental factors at the site selected, such as soil type, slope, exposure, and drainage; (b) the grouping in the most suitable locations of all the adapted plants of many genera or species; (c) making them available for general observation and detailed study; and (d) preserving for reference, identification, and classification, herbarium specimens of all plant materials likely to be of value in this country.

Work at the National Arboretum for the duration of the war was primarily on a maintenance basis and is carried on that basis at this time, using the skeleton force for the best possible maintenace of the areas already developed and for the preparation of areas which must be handled on account of the growth of plant materials in the nursery. The permanent collections, up to the present time, consist of the basic collections of the Conifers, special collections of Leguminosae, and of the genera Acer (maple), Ilex (holly), and Magnolia (magnolia). In addition, primary plantations have been made of selected species of conifers in the one hill site that is to be converted to a planting of conifers in mass.

Work also includes the necessary routine care of drainage and road systems. Drainage is a constantly increasing problem because the development of areas north of the Arboretum property into residential area brings constantly increasing surface drainage into Hickey Creek through the Arboretum. The problem is serious since the paved areas in the residential districts bring the run-off quickly to the creek.

(h) Special Research Fund, Department of Agriculture
(Allotment to Bureau of Plant Industry, Soils, and Agricultural Engineering)

This budget schedule covers obligations under an allotment for work conducted under Special Research Projects and Regional Laboratories.

(i) Salaries and Expenses, Soil Conservation Service
(Allotment to Bureau of Plant Industry, Soils, and Agricultural Engineering)

This budget schedule shows obligations under an allotment for inspection and correlation of surveys made in connection with the program of the Soil Conservation Service.

All soil survey inspection and correlation work in the Department of Agriculture was consolidated in the then Bureau of Plant Industry by an order of the Secretary, effective September 1, 1942. The consolidation was made with a view to achieving more effective administration and conduct of the work so that all soil classification and mapping done by the Department would fulfill the immediate needs of agricultural conservation and adjustment programs as well as contribute to the basic soil survey of the whole country.

The surveys of the Soil Conservation Service are designed primarily to meet needs in developing conservation plans for individual farms. In order that the information obtained in these surveys can best meet these needs and at the same time contribute effectively to the basic soil survey program of the Department and cooperating State Agricultural Experiment Stations, the surveys must be inspected and correlated to insure that the soils are properly identified and accurately mapped and classified. The classification of soils on a uniform nationwide basis is essential for effective application of results of plant and soil research, including research on erosion control, to specific fields, farms, and rural communities.

Under procedures developed in agreement with the Soil Conservation Service, inspectors of the Soil Survey paid from this allotment examine each area where surveys are planned to determine what soil types are present, and prepare a legend to be followed in mapping these soils. This constitutes the first inspection of the area, after which one or more progress inspections and a final field inspection are made to determine whether the surveyors have properly identified the soils and have shown them accurately on the maps. The results are then checked by the regional inspector with results of other surveys in the region, and any necessary corrections made to insure uniformity in classification and nomenclature of soils throughout the region.

The work involves close cooperation with the State Experiment Stations in the improvement of soil type definition and classification in the light of research findings.

(j) Emergency Fund for the President, National Defense (Allotment to Bureau of Plant Industry, Soils, and Agricultural Engineering)

This budget schedule covers obligations for the fiscal years 1945 and 1946 under an allotment for emergency plant disease prevention.

(k) Rubber Investigations

This budget schedule covers the unobligated balance of an appropriation made by the Second Deficiency Appropriation Act, 1940, for surveys and investigations directed toward plantation rubber production in the Western Hemisphere.

Continuation of the program for development of rubber production in the Western Hemisphere is provided for by transfer from the Department of State appropriation "Cooperation With the American Republics." A transfer of $319,186 to the Department for this purpose will be made for the fiscal year 1946 and the Budget estimates for 1947 contemplate the transfer of $340,746 for this work in the fiscal year 1947. The item is considered by the Subcommittee on Appropriations for State, Commerce, and Justice, as a part of the program for cooperation with the American Republics being conducted under the general supervision of the Secretary of State.

(l) Emergency Rubber Project, Department of Agriculture (Allotment to Bureau of Plant Industry, Soils, and Agricultural Engineering)

This budget schedule covers obligations during 1945 and 1946 under an allotment for production, culture, and handling investigations on guayule and other emergency rubber crops (1946 allotment estimate is limited to guayule). In view of the pending liquidation of the Project, it is not contemplated that an allotment will be made for this purpose in 1947.

(m) Working Funds (Bureau of Plant Industry, Soils, and Agricultural Engineering)

This budget schedule covers obligations under advances, pursuant to Section 601 of the Economy Act of June 30, 1932, for services performed for various agencies as indicated in the following statement of obligations under supplemental funds.

STATEMENT OF OBLIGATIONS UNDER SUPPLEMENTAL FUNDS
(1945 and 1946 figures include overtime costs)

Item	Obligations, 1945	Estimated obligations, 1946	Estimated obligations, 1947
Special Research Fund, Department of Agriculture:			
Special research laboratories	$322,374	$320,803	$315,407
Special research projects	128,135	128,620	126,660
Total, Special Research Fund	450,509	449,423	442,067
Soil Conservation Service (Allotment to BPIS&AE): Inspection and correlation of soil surveys made by the Soil Conservation Service	179,314	195,000	192,400
Emergency Fund for the President, National Defense: For emergency plant disease prevention	170,683	7,000	- - -
Emergency Rubber Project, Department of Agriculture: Investigations directed toward the production of rubber from guayule and other rubber-bearing plants	277,590	103,280	- - -
Working Funds (Bureau of Plant Industry, Soils and Agricultural Engineering) Advances from:			
War Production Board:			
Investigations in food compression and packaging of dehydrated compressed food products	3,938	- - -	- - -
Investigations on ammonium nitrate as a fertilizer	5,112	- - -	- - -
Total, War Production Board	9,050	- - -	- - -
Commodity Credit Corporation: Development of methods of properly caring for grain in storage	2,333	- - -	- - -
State Department: Cooperation with the Chinese Government in the study of agricultural problems	3,564	- - -	- - -

(Continued on next page)

Item	Obligations, 1945	Estimated obligations, 1946	Estimated obligations, 1947
Working Funds (Bureau of Plant Industry, Soils and Agricultural Engineering) Advances from: (Cont'd)			
War Department: Investigations on effect of fungi decay on Ordnance material, and methods for control	744	- - -	- - -
Total, Working Funds	15,691	- - -	- - -
Cooperation with American Republics (Transfer from State): 1/			
Investigation directed toward plantation rubber production in the Western Hemisphere	295,800	319,186	340,746
Total, Obligations Under Supplemental Funds	1,389,587	1,073,889	975,213

1/ The budget schedule relating to this project appears in the State Department chapter of the Budget.

PASSENGER-CARRYING VEHICLES

The 1947 estimates for "Salaries and Expenses" of the Bureau of Plant Industry, Soils, and Agricultural Engineering contemplate the replacement of 37 automobiles (approximately 20 percent of the number owned and operated) at an estimated net cost of $27,750; and the purchase of 6 additional vehicles at an estimated cost of $6,300 for use on activities for which increases are requested in the estimates. The cars to be replaced will average 9 years of service and will have been driven an estimated average of 67,000 miles by July 1, 1946. Cars are essential for use where other means of transportation are inadequate or not available, and with the average age and mileage of present cars considerably above an efficient operating level, replacements should be made as soon as possible.

The 1947 estimates also contemplate the purchase of 4 additional cars needed for inspection and correlation, by the Bureau, of soil surveys made by the Soil Conservation Service. On this latter work, the inspectors frequently must make inspections 100 or 200 miles and more from headquarters, usually accompanied by 3 or 4 other scientists. The use of trucks, therefore, is quite unsatisfactory, and most of the areas are not accesible by common carrier. The present inadequate number of cars is due in part to the fact that the work was organized after the war had begun, and cars have

not been available. The four additional cars would provide transportation necessary for efficient conduct of the inspection program.

If procurement of the new vehicles should prove to be impracticable, the funds estimated for this purpose would be needed for additional costs of keeping present vehicles in operation and of performing travel by other means.

PENALTY MAIL
Section 2, Public Law 364, 78th Congress
(Allotment to Bureau of Plant Industry,
Soils, and Agricultural Engineering)

	1945	1946	1947	Increase (+) or Decrease (-), 1947 over 1946
Category 1	$1,300	$1,800	$2,000	+$ 200
Category 2	3,925	5,400	6,700	+1,300
Totals	5,225	7,200	8,700	+1,500

Category 1 consists of the mailing of farmers' bulletins and other publications furnished in response to specific requests for information which results from the research work of this Bureau on the development of improved disease-resistant crop varieties; methods of soil management and cultural and fertilizer practices maintaining soil fertility and giving maximum production on a permanent basis; control of plant diseases and weeds; agricultural engineering, etc.

Category 2 consists of administrative and operating correspondence with field personnel located throughout the United States and with the State experiment stations and other agencies cooperating with the Bureau in its research programs, and mailing of vouchers, payrolls, and other operating documents. There also is a considerable exchange of small parcels of seed and other plant materials with cooperators and employees of the Bureau.

The increase of $1,500 for 1947 will be required to meet the cost of increased mailings in connection with additional cooperative relationships and correspondence with State agricultural experiment stations and other agencies, and for the dissemination of additional information on the research of the Bureau, resulting from an enlarged program of work for which there are increases totaling approximately $1,285,000 in the estimates for 1947.

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

(a) Salaries and Expenses - Preamble

CHANGES IN LANGUAGE

The estimates include proposed changes in the language of the preamble as follows (new language underscored, deleted matter enclosed with brackets):

Change No.	
1	For expenses [, independently or in cooperation with public or private agencies, including individuals, corporations, or foreign governments,] necessary for investigations, experiments, demonstrations and surveys for the promotion of economic entomology, for investigating and ascertaining the best means of destroying insects and related pests injurious to agriculture, for importing useful and beneficial insects and bacterial, fungal, and other diseases of insects and related pests, for investigating and ascertaining the best means of destroying insects affecting man and animals, and the best ways of utilizing beneficial insects, for carrying into effect the provisions of the Plant Quarantine Act of August 20, 1912, as amended (7. U.S.C. 151-167), the Honey Bee Act (7 U.S.C. 281-[282] 283), the Insect Pest Act (7 U.S.C. 141-144), the Mexican Border Act (7 U.S.C. 149) and the Department of
2	Agriculture Organic Act of 1944 ([Public Law 425] 7 U.S.C. 147a), authorizing the eradication, control, and prevention of spread of injurious insects and plant pests; including the operation and maintenance of airplanes and the purchase of not to exceed seven, and not to exceed [$544,493] $625,560 for personal services in the District of Columbia, as follows:

The first change proposes that the language contained in the preamble in the 1946 Agricultural Appropriation Act, relating to cooperation in effectuating the purposes for which the appropriation was made, be deleted in the 1947 fiscal year.

The sole purpose of the proposed deletion of this language from the appropriation is to shorten and simplify the item. The clause proposed for deletion is considered surplusage and, therefore, need not be retained in the annual appropriation act, the cooperative work being authorized by the Act of May 15, 1862 (5 U.S.C. 511), establishing the Department of Agriculture (as further implemented by the Act of July 24, 1919 (5 U.S.C. 563-564)), and the Department of Agriculture Organic Act of 1944 (7 U.S.C. 147a), which provides authority for cooperating with the groups referred to in the language to be deleted. Elimination of the language from the annual appropriation act will not--in any way--change the scope or character of the work performed under this appropriation item, or the authority of the Department to cooperate with other agencies, institutions, organizations, or others in the conduct of such work.

The second change expands the code reference for the Honey Bee Act to include 7 U.S.C. 283, the reference appearing in Supplement IV to the 1940 edition of the U.S. Code for Section 103 of the Act of September 21, 1944 (Department of Agriculture Organic Act of 1944), which is applicable to the purposes of this appropriation.

(b) Insect Investigations

Appropriation Act, 1946		$2,114,900
Anticipated supplemental for additional costs due to Federal Employees Pay Act		+270,000
Total anticipated available, 1946		2,384,000
Budget estimate, 1947		2,579,000
Change for 1947:		
Overtime decrease	-42,200	
Increase	+236,300	+194,100

PROJECT STATEMENT

[Note.-Amounts in parenthesis opposite the alphabetically designated sub-projects represent the details of the numerically identified main projects which immediately precede]

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Fruit insects	400,011	456,400	493,000	+36,600 (1)
(a) Deciduous fruit insects	(190,411)	(217,600)	(218,500)	(+900)
(b) Citrus and other sub-tropical fruit insects	(43,600)	(48,800)	(49,000)	(+200)
(c) Fruitflies which are potential pests in Continental United States	(65,200)	(71,400)	(106,400)	(+35,000)
(d) Japanese beetle investigations	(100,800)	(118,600)	(119,100)	(+500)
2. Forest insects	215,853	287,000	288,900	+1,900 (2)
(a) Insects attacking mature timber	(21,400)	(23,900)	(24,000)	(+100)
(b) Insects attacking second growth timber	(46,000)	(51,400)	(51,800)	(+400)
(c) Insects attacking forest products	(4,900)	(5,500)	(5,500)	- - -
(d) Termites	(14,653)	(16,200)	(16,300)	(+100)
(e) Insect vectors of forest tree diseases	(15,100)	(17,000)	(17,100)	(+100)
(f) Surveys and advice to land-managing agencies	(52,900)	(59,000)	(59,400)	(+400)
(g) Spruce budworm	(50,100)	(80,300)	(80,900)	(+600)
(h) Phloem necrosis	(10,800)	(33,700)	(33,900)	(+200)

PROJECT STATEMENT (Continued)

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
3. Truck crop and garden insects	287,011	321,700	385,600	+63,900 (3)
(a) Truck crop insects	(236,211)	(264,700)	(328,300)	(+63,600)
(b) Tobacco insects	(50,800)	(57,000)	(57,300)	(+300)
4. Cereal and forage insects	354,720	399,800	457,700	+57,900 (4)
(a) Cereal and forage insects	(328,520)	(370,200)	(427,900)	(+57,700)
(b) Sugarcane insects	(26,200)	(29,600)	(29,800)	(+200)
5. Cotton insects	142,401	159,600	160,800	+1,200 (5)
(a) Boll weevil	(44,300)	(36,700)	(37,000)	(+300)
(b) Pink bollworm investigations	(29,700)	(41,500)	(41,900)	(+400)
(c) Bollworm	(11,400)	(12,800)	(12,900)	(+100)
(d) Plant bugs affecting irrigated cotton	(15,600)	(17,600)	(17,700)	(+100)
(e) Cotton fleahopper and related insects	(12,000)	(14,400)	(14,500)	(+100)
(f) Cotton aphid	(22,700)	(28,600)	(28,800)	(+200)
(g) Various cotton insects	(6,701)	(8,000)	(8,000)	- - -
6. Bee culture	84,921	91,100	149,500	+58,400 (6)
7. Insects affecting man and animals	157,787	176,600	189,500	+12,900 (7)
(a) Insects affecting man and animals	(132,787)	(149,600)	(162,300)	(+12,700)
(b) Household insects	(25,000)	(27,000)	(27,200)	(+200)
8. Insect pest survey	6,617	7,600	7,700	+100 (8)
9. Identification and classification of insects	120,593	136,800	138,100	+1,300 (8)
10. Foreign parasites	29,804	33,100	33,300	+200 (8)
11. Control investigations	72,573	134,700	135,800	+1,100 (8)
12. Insecticide and fungicide investigations	121,432	138,300	139,100	+800 (8)
13. Overtime pay	282,834	42,200	- - -	-42,200
Covered into Treasury in accordance with Public Law 529	485			
Unobligated balance	36,453	- - -	- - -	- - -
Total available	2,313,495	2,384,900	2,579,000	+194,100
Anticipated supplemental	- - -	-270,000	- - -	
Total estimate or appropriation (1945 adjusted for comparability)	2,313,495	2,114,900	2,579,000	

INCREASES OR DECREASES

The net increase of $194,100 in this item for 1947 consists of the $42,200 decrease for overtime and the following:

(1) An increase of $36,600 under the project "Fruit Insects" composed of:

(a) An increase of $35,000 to provide for (1) an investigation of a destructive fruit fly in Brazil that constitutes a serious threat to the citrus industry of the U.S. and (2) an investigation in cooperation with the Bureau of Plant Industry, Soils and Agricultural Engineering and Brazilian government of tristeza disease, a new and serious menace to citrus that may be insect borne.

Objective: To secure data on the hosts and habits of the fruit fly Anastrepha fraterculus in Brazil and develop methods by which it may be controlled should it gain entrance into the United States including the determination of means of applying the vapor-heat method of treating fruit so it can be shipped without danger of spreading the pest; and to investigate the relation of insects to the tristeza disease of citrus.

The Problem and Its Significance: Information recently secured has disclosed that the fruit fly which is most destructive to citrus fruits produced in the Brazilian states of Sao Paulo and Rio de Janeiro is the South American species, Anastrepha fraterculus. In some areas this pest destroys as high as 60 to 70 percent of the crop. This insect attacks peaches and other fruits and in certain districts is a serious pest of these fruits. Knowledge of its life history and habits are meager and no satisfactory methods of controlling it are known. It is not known if fruit that may be infested by it can be treated to kill the eggs and larvae by temperatures that can be applied without injury to the fruit.

The increase of transportation between Brazil and southern ports of the United States, especially direct plane service will provide opportunity for this pest to become established in our country, which may not be entirely prevented by regulatory measures. It is highly important that facts be secured so it can be effectively combated should it become established in our country. It is also important to have available a fruit treatment which would provide for safe movement of crops throughout the United States should this pest become established in some part of this country.

The development of facts which would make it practicable to treat fruit by the vapor-heat or other methods so it could enter commerce without risk of spreading the fruit fly might make it possible to authorize the use of treatment under supervision as a condition of its entry into the United States, and thus remove a pest risk barrier to the free exchange of certain fruit products between our country and those areas where this important potential pest occurs.

The tristeza disease of citrus in Brazil has shown tremendous destructive powers. The statistical office of Limeira reports that in 1939 there were 2,000,000 citrus trees in Brazil. There are now only 700,000, due chiefly to tristeza. It is understood that in Sorocaba there were 1,500,000 trees in 1939. Last year (1945) only 10,000 were left. The disease is most destructive to citrus on sour root stocks and a high percentage of our trees are on such susceptible stock. Little is known of the nature of the disease and nothing of its means of spread. It resembles a virus disease and such diseases are usually carried by insects. This disease is similar to if not the same as one which has recently appeared in California and it is highly important that essential facts regarding the relation that insects have to it be secured at the earliest practicable date. Studies of that nature can only be carried out where material is available and where they will not be interferred with by drastic eradication efforts.

Plan of work: The recommended increase of $35,000 would provide for (1) an investigation of the South American fruit fly in Brazil for the purpose of developing an effective control or eradication procedure should the pest gain a foothold in the United States, (2) developing an effective method of destroying this fruit fly in packed fruit either by the vapor-heat method or other suitable process, (3) determine the relation of insects to the spread of tristeza disease. A laboratory would be established at one of the Brazilian Experiment stations, two of which have extended cordial invitations to the Department of Agriculture to cooperate with them in these investigations. These experment stations have offered to provide laboratory space and considerable equipment as well as citrus plantings.

The Bureau of Plant Industry, Soils and Agricultural Engineering plans to carry on studies of tristeza in Brazil and insect transmission experiments would be conducted in cooperation with that bureau and the Brazilian authorities. The information obtained will be of great value in our efforts to exclude from this country the various kinds of destructive fruit flies and the tristeza disease. It will also be of material aid to South American republics in providing means by which fruit may be made safe to enter international trade. The problems are complicated and will no doubt require several years to solve.

(b) An increase of $1,600 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(2) An increase of $1,900 under the project "Forest insects" for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(3) An increase of $63,900 under the project "Truck crop and garden insects," composed of:

(a) An increase of $48,100 for investigations of insects affecting ornamental plants and mushrooms.

Objective: To develop and perfect methods of control of insects and related pests affecting greenhouse ornamentals, flowering bulbs, tulips, lilies, and mushrooms.

The Problem and Its Significance: The flowering and other ornamental plants grown under glass or out of doors as well as mushrooms are subject to attack by a large array of insect pests and related forms. The production of these flowers and mushrooms constitutes a highly specialized industry located in various parts of this country. It involves an outlay of about $300,000,000 in equipment. The flower crop produced has been estimated as being worth, on an annual basis, $186,000,000. No recent estimate is available as to the value of the mushroom crop but some years ago it was estimated at about $5,000,000.

Plan of Work: The plan is to re-establish the investigations which were discontinued during the fiscal year 1943 because entomological work on ornamentals was not considered essential to the war effort. Investigations would be carried on at the Agricultural Research Center, Beltsville, Md., where greenhouses are available for this type of work and other studies would be conducted in cooperation with individual greenhouse men. These studies will involve the development of suitable fumigants and sprays for the control of such important pests as thrips, red spiders, aphids, and scale insects. Preliminary work on mushrooms would be conducted at the Agricultural Research Center and large-scale tests on the control of mushroom mites and flies will be carried on in cooperation with the Mushroom Growers Association in commercial houses. Particular emphasis would be placed on the development of a remedy which can be applied to the mushroom spawning beds in order to prevent mushroom fly infestations from building up in the houses. Studies would be conducted in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering on insect vectors of virus diseases of lilies, tulips, and other ornamental bulbs and flowers. Work would be carried on to develop field control of the bulb fly.

(b) An increase of $14,400 for investigations to develop soil fumigants for the control of wireworms in irrigated lands.

Problem and Its Significance: Wireworms infest a large proportion of the highly developed and valuable irrigated lands devoted to vegetable production in the West. Some of the lands in California, estimated to reach a total of approximately 250,000 acres, are so badly infested with these pests that such acreages have been rendered unproductive. Several species of wireworms are involved in these depredations and since each of these species varies greatly in its habits and in its response to insecticides and other control methods, as well as to the prevailing agronomic practices, the problem of controlling individual species or associated species requires extensive and careful investigation. Several new fumigants have been developed which show promise of controlling wireworms in high value truck lands.

Plan of Work: The proposed increase in activities would be an expansion of the wireworm investigations now in progress in southern California with headquarters at Ventura. These investigations will involve studies of the effect on wireworms and on the plants, of soil fumigants, soil insecticides, and the effect of crop rotations, cover crops, and other agronomic practices on subsequent wireworm populations. Special attention will be devoted to such insecticides as DD mixture, DDT, ethylene dibromide, naphthalene, dichloroethyl ether and ethide and comparisons made between the relative efficiency, cost, practicability and health hazards involved in the instance of each of the materials tested.

(c) An increase of $1,400 for placing on a full year basis in 1947, within grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(4) An increase of $57,900 under the project "Cereal and forage insects," composed of:

(a) An increase of $12,500 for enlargement and intensification of research on the development of insecticides for control of the European corn borer.

The Problem: The European corn borer is a serious insect pest of corn which has now spread throughout practically the entire Corn Belt from New England to North Carolina and west to Kansas and Nebraska. Losses of corn caused by this insect were estimated at $33,300,000 in 1943 and $22,700,000 in 1944. It has been known to cause almost complete losses of the crop in certain areas in some years, as in Western Ontario in 1926 following which the production of this very important crop in that area was greatly reduced for a number of years.

Significance: Actual and potential losses due to the corn borer in the main corn producing area of the United States are an immediate and serious threat to the welfare of agriculture and the general public. No single satisfactory control measure is known. Intensive research has indicated that the development of methods of using insecticides is one of the most promising controls that may be devised to prevent these losses. With the recent spread of the borer through the main Corn Belt the improvement of this and other control measures is increasingly urgent, and additional funds are needed for a fully adequate prosecution of this activity in cooperation with the respective Federal and State Experiment Station agricultural engineers and entomologists.

Plan of Work: The work on the improvement and reduction in cost of insecticidal methods of control in cooperation with Federal agricultural engineers and official entomologists in many states would be expanded. This involves extensive laboratory and field trials of many different kinds and formulations of insecticides and the devising of efficient ground and aerial equipment for their application. These studies would be headquartered at Toledo, Ohio.

(b) An increase of $27,000 to investigate insects attacking alfalfa and clover seed crops in the North Central and Northeastern States.

Objective: To determine the identify, habits and importance of insects causing reductions in yield of alfalfa and clover seed and develop methods for their control.

The Problem: The acreages of alfalfa and red clover grown for seed and for hay in the North-central States greatly exceed those in the Rocky Mountain and Pacific States, but the yields of seed per acre are much lower and less certain. Thus, the production of these seeds is poorest in the North-central and Northeastern States where they are needed most, and these regions are obliged to depend to a considerable extent on the Rocky Mountain and Pacific States for their seed supplies. Even though seed yields are greater in the Western States, studies there have shown that certain species of small sucking insects, mainly Lygus spp., greatly reduce alfalfa seed yields and that yields can be much increased by control of these insects through cultural and insecticidal means. Fragmentary information also indicates that these insects and possibly others are at least partially responsible for the very low seed yields in the North-central and Northeastern States.

Significance: With a growing need for increased acreages of alfalfa and clover hay and pasture as a result of war and post-war conditions there will be a corresponding need of increasing the supply of seed for these crops. It appears that one of the best ways of meeting this need would be by increasing the yields of seed per acre through the prevention of losses caused by insects. In one experimental trial in Utah, for instance, plots of seed alfalfa treated with an insecticide yielded over 7 bushels per acre whereas the crop on untreated plots was practically a total loss. Judging from the severe losses in alfalfa seed yields known to be caused by insects in the Western States and the large increases in yield that have been obtained in that region through their control, it is thought that an extension of the investigation of insect damage and control in seed alfalfa and clover into the North-central and Northeastern States would be highly desirable and fully warranted. Lygus spp. and other sucking insects destroy a large portion of the buds, flowers and immature seeds of alfalfa and possibly also of clover. Studies will aim to develop ways to control the injurious forms which will not be injurious to the honey bee and other insects which are essential to pollination. The plants must produce flowers which can be pollinated. The investigations are an essential part of any efforts to utilize bees more effectively as pollinating agents and the work will be coordinated with such efforts and the work of agronomists.

Plan of Work: Two P-3 entomologists would be employed, one to be stationed at some favorable point in the Northeastern States and one to be stationed at some favorable point in the North-central States, where they would investigate the identity, habits and insecticidal and cultural control of the insects attacking seed alfalfa and clovers, in close cooperation with Department or State Experiment Station agronomists working on these crops, and with Department or State Experiment Station entomologists working on the utilization of bees as pollinating agents. Laboratory and office facilities will be provided them by or in close proximity

to cooperating State Experiment Stations. Additional subprofessional and clerical help would be given the field station staff already working on this project at Delta, Utah.

(c) An increase of $12,500 to study the biology of and develop practicable methods for the control of the southwestern corn borer in the Central States.

The Problem: The southwestern corn borer breeds in corn, sorghum, sugarcane, broomcorn and Johnson grass. Corn is apparently its favorite host and in recent years it has rapidly spread northward and eastward in Texas, Oklahoma, Kansas and Nebraska into the western edge of the main Corn Belt where it passes through two generations a year and is causing severe losses of corn, and where there is urgent need of more effective control measures than are yet available.

Significance: This borer severely injures growing corn and has already caused large reductions in corn acreage in some central Kansas counties. In six of these counties, for instance, the acreage planted was reduced from 116,000 in 1943 to about 44,000 in 1944 as a direct result of losses due to this pest. According to present indications it will become a very important detriment to the successful production of corn as it spreads into the main corn growing areas to the north and east unless more practical control measures can be found.

Plan of Work: To employ two well-trained entomologists and provide them with adequate assistance and facilities for (1) the study of the habits, parasites, host plants, importance and spread of the borer and methods for its control by means of cultural measures and insecticides; (2) to test varieties of corn resistant to the European corn borer to appraise their resistance to the southwestern borer; and (3) to colonize parasites which may aid in control. Headquarters will be located at Bureau field stations or State Experiment Stations in the South-central States. The activities will be conducted cooperatively with State Station entomologists and corn breeders, and the Bureau of Plant Industry, Soils and Agricultural Engineering.

(d) An increase of $3,500 to provide for entomological studies on insects affecting crops in Alaska.

Objective: To evaluate insect problems and gather information that may serve as a basis for combating injurious and noxious species and means of utilizing beneficial forms so that the agricultural potentialities of Alaska may be utilized.

The Problem and its Significance: It is important that Alaska have a sound development in the economy of the United States. This is essential in order to provide the maximum opportunity for returning veterans to establish themselves in agricultural and related pursuits.

Knowledge of the various insect pests of field crops in various parts of Alaska is meager. Cutworms and root maggots are recognized as serious pests and no doubt several others cause losses which may be

heavy during certain years. It is planned to determine the nature, extent and severity of these problems, to consider the applicability to Alaskan conditions of control measures that may be practicable under those conditions.

Plan of Work: An entomologist familiar with field crop pest problems would be assigned to this work in association with entomologists working on insects affecting man and livestock and with agronomists studying cereal and forage crops. By this arrangement clerical help and equipment could be shared. Cooperation would be maintained with the Agricultural Experiment Station workers at Fairbanks and in the Matanuska Valley. The initial work would be primarily of an exploratory nature but during the season of 1947 it is hoped to undertake some preliminary tests of control measures developed in the United States to determine their applicability to the Alaskan problems.

(e) An increase of $2,400 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(5) An increase of $1,200 under the project "Cotton insects" for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(6) An increase of $58,400 under the project "Bee culture" composed of:

(a) An increase of $57,800 to inaugurate an investigation on the insect pollination of agricultural crops and of the hazards to such insects from agricultural insecticides.

Objective: To develop methods for the most effective use of honeybees and other pollinating insects in the pollination of crops that are dependent on insects for the production of seed and fruit, including the conservation, propagation and protection from poisoning of pollinating insects.

The Problem and its Significance: The principal pollinating insects are honeybees, bumblebees and other native bees, certain flies, beetles and other insects. Many of the economic crops arecompletely dependent on pollinating insects for the production of seed and fruit, while others produce more heavily when pollinating insects are abundant. Thehoneybee is important in the pollination of some 50 crops grown in this country, including such diverse crops as orchard fruits, cucumbers and melons, buckwheat, alfalfa and most varieties of clover as well as many varieties of vegetables grown for seed.

In earlier years when tracts of cultivated field crops and orchards were relatively small the native pollinating insects and the few honeybees that were then available adequately took care of pollination requirements. Undisturbed nesting sites such as woodlands, pastures, wasteland, fence and hedge rows, harbored nesting sites for pollinating

insects and insect pollination, attracted little or no attention. The picture has changed completely. Vast acreages of continuous tracts of a single crop requiring insect pollination are to be found from coast to coast. This has necessitated a proportionate increase in local pollinating insect populations. Modern agricultural practices, however, militate against the conservation and propagation of beneficial insects, and in many respects hold back the development of the beekeeping industry. The present era has necessitated the widespread use of insecticides. This practice alone is having serious effects on beekeeping and is unquestionably responsible for the decimation of many species of wild pollinating insects. Inadequate pollination is clearly reflected, to give one outstanding example, in a steady and disastrous decline in the per-acre yields of alfalfa and various clover seed crops, and this, in spite of the application of the best known agronomic practices.

The problem is not peculiar to any one State. It is nation-wide. No one State or agency has been ble to cope with the problem adequately. The economic significance of inadequate pollination is difficult to estimate since so many branches of agriculture are either directly or indirectly involved. Even the production of meat, milk and butter are affected, inasmuch as the dairy and livestock industry are largely dependent upon the profitable growing of legumes, and these in turn are almost completely dependent on insect pollination for the production of seed.

Plan of Work: The work would involve studies of specific methods of beekeeping management for pollination purposes, the orderly deployment and development of the beekeeping industry for most effective pollination, and the identification of factors influencing effective pollination by honeybees.

Advantage would be taken of existing field laboratories of the Bureau. In addition it is contemplated that work would be done at other locations in cooperation with the agricultural experiment stations and with various Government agencies.

(b) An increase of $600 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(7) An increase of $12,900 under the project "Insects affecting man and animals" composed of:

(a) An increase of $11,500 to provide for entomological studies on insects affecting man and animals in Alaska.

Objective: To acquire an adequate knowledge of the species of insects in Alaska which affect man and animals and the distribution and seasonable abundance of these insects.

The Problem and its Significance: Mosquitoes, blackflies, and other biting insects are extremely abundant throughout much of Alaska. These pests are a serious handicap to agriculture, mining, lumbering, and fishing operations. Heavy livestock losses are also chargeable to these pests. A more adequate knowledge of the species involved, their distribution and seasonable abundance is necessary for the development and application of effective control measures. It is planned to consider how far control procedures developed in the United States can be utilized and to make tests of some of those that appear most promising. Upon the development of practical measures of control of these pests depends to a large extent the successful development of Alaska.

Plan of Work: Two entomologists well prepared in the field of insects affecting man and livestock would be headquartered in Alaska, probably at the Agricultural Experiment Station at Fairbanks. These men in cooperation with the Alaska Agricultural Experiment Station, the Alaskan Railway and others concerned with the development of the agricultural, lumbering, mining, and fishing industries, would carry on a survey to determine the nature of mosquito, blackfly and punkie problems, especially in the Fairbanks and Matanuska areas. This preliminary work would be largely in the nature of a survey and gathering of information on the species involved and life history, habits, and seasonal and local abundance. Such information to form a basis for the conduct of control undertakings. In the spring of 1947 it is planned to make preliminary tests of fog generators and, if possible, aerial applications of DDT insecticides.

(b) An increase of $1,400 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(8) Increases totaling $3,500 under Projects 8 to 12, inclusive, as shown on the project statement, for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(Continued on next page)

WORK UNDER THIS APPROPRIATION

Objectives: (1) To develop means whereby the growers of fruits, nuts, truck and garden crops, cereal, forage and range crops, cotton, tobacco, sugar plants and other agricultural products, can control insect pests more effectively or more economically, thus increasing the net returns from their operations and insuring an ample supply of high-quality agricultural products;

(2) To devise the most effective and economical means of preventing or controlling insect damage to forest and shade trees, forest products and shrubs;

(3) To reduce losses from bee diseases, to promote better methods of apiary management for honey and wax production and for pollination, and to provide for the use of superior strains of bees;

(4) To develop control measures for those insects which transmit disease, annoy man, and attack livestock;

(5) To devise the most effective and economical means of preventing or controlling insect damage to stored agricultural products, foods and fabrics;

(6) To identify insects and allied organisms for the quarantine, control and research activities of the Bureau of Entomology and Plant Quarantine and other Federal and State agencies, farmers, pest control operators, and other private individuals of the United States, as well as for foreign institutions; and to collect, maintain, and furnish information as to the presence and abundance of insect pests;

(7) To develop methods and apparatus for freeing commodities of pests under plant quarantine regulations so that they can move freely and safely in commerce; and to improve the chemical materials now employed in controlling insects, to develop new and better chemical materials, and to devise improved apparatus and methods for their application.

The Problem and its Significance: The problems encountered and the importance of solving them are discussed in the following paragraphs which are numbered to correspond with the objectives stated in the preceding section.

(1) Unfortunately all crops are subject to serious attack by insect pests. Losses due to these attacks vary with the crop and the season but the average annual loss from this source is high in spite of the available knowledge about insect control. These losses are due in part to failure to apply known methods thoroughly and timely, in part to the imperfect control measures available for many pests, and to their cost. For example, including the cost of control measures, codling moth still exacts a toll of $31,000,000 per year and some growers spend $50 to $60 per acre for control and still suffer losses. Corn earworm causes an average annual loss of $79,000,000 to corn alone and in addition

does serious damage to tomatoes and cotton. Probably the most reliable figures on insect losses over a period of years for any crop are those for cotton accumulated by the Bureau of Agricultural Economics. These indicate an average reduction from full yield due to insects of 13.1% per year for the period 1923-1943. The monetary loss figured on average farm prices during this period excluding the cost of the control applied varied from $74,000,000 in 1931 to $769,000,000 in 1923. Truck crops are especially subject to attack by a great variety of pests and annual losses are high. Losses of this type represent not only a severe financial burden to producers but also constitute a grave handicap to agricultural production in the war effort, to production to feed and clothe our population and to meet world demand in the post war period.

(2) Insects affecting forests and forest products are estimated to cause losses of more than $100,000,000 annually. This destruction is particularly serious because of the greatly increased demands for lumber and other forest products. This makes it particularly essential to protect the reserve supply of standing timber and the large quantities which have been cut for lumber and other purposes. It is also important to be in position to advise forest managing agencies, wood using industries, and those responsible for construction activities, all of which have called for assistance and advice in applying control measures.

(3) Beekeeping is practiced in every state of the United States. There are more than 5,000,000 colonies representing an investment of $55,000,000 with an annual production of about 200,000,000 pounds of honey, 5,000,000 pounds of beeswax, and $500,000 worth of live bees for shipping into honey-producing areas. This represents an important commercial investment which should be protected by the best advice and service possible to the beekeeper.

It is even more important, however, to promote apiculture because of its relationship to the pollination of agricultural crops. Field studies indicate that honeybees perform at least 80% of the pollination which is essential to the production of almonds, apples, pears, plums, cherries, small fruits, melons, cucumbers, vegetable seeds, cotton, clover and alfalfa seed. It is also of importance in the maintenance of pastures and ranges. When the values of these crops are considered, it becomes apparent that the encouragement of beekeeping has an importance in the field of agricultural production far beyond the value of the wax and honey produced.

(4) The part played by insects in the transmission of disease to man and animals in the United States and the losses attributable to direct attack on farm animals is so important as to make it imperative that the habits and life history of these insects be clearly understood so that effective control measures can be developed. Production of beef, mutton, poultry, Mohair, wool, hides and dairy products is greatly affected by the depredations of many insect pests such as screwworms, biting flies, cattle grubs and lice. Horse raising and farming operations are also adversely affected by insects such as

horse bots, stable flies and buffalo gnats. Malaria has always had a considerable incidence and fatality and in certain states the loss of work time and operating efficiency resulting from this disease is extremely high. It seems inevitable that troops returning to the United States from malaria infested areas will add to the problem of control of such diseases as malaria, dengue, and filariasis, all of which are carried by species of mosquitoes now within the United States.

(5) The insect problem in relation to agricultural products by no means ceases with the harvesting of crops. Tremendous damage has been done by insects to stored fruits, tobacco, grain, and fabrics. It is estimated, for example, that grain and flour weevils and moths have damaged stored grains and cereal products to the extent of more than $360,000,000 annually. It is important to give every possible assistance to farmers, millers, warehouse operators, and others in protecting these products.

(6) There are many hundreds of thousands of different kinds of insects. Numerous species within many given groups resemble each other so closely as to appear identical but frequently have such different habits as to require different kinds of control or regulation. The exact identification of insects is therefore fundamental to research, control, and regulatory activities as well as to the farmer who must know the identity of an insect before proper control measures can be applied. Identification of many species can be made only by experts from specimens especially prepared for study and in many cases only after extended research. It is, of course, fundamental that there be adequate and up-to-date information as to the distribution of various insects throughout the United States. This is essential not only to intelligent control efforts but also to the economical and effective use of our present restricted supply of insecticides.

(7) Despite the end of the war, there is still a shortage of certain standard insecticidal materials. At the same time there is a large demand for certain insecticides for the protection of agricultural crops and also to safeguard groups from disease-carrying insects. It is imperative, therefore, that new and effective insecticides be developed and that every effort be made to devise apparatus and methods which will make it possible to apply new insecticidal materials to the best advantage and to increase the effectiveness of those already in use. It is also essential that the restriction of movement of commercial commodities under quarantine regulations be held to an absolute minimum. This may best be accomplished by continued development of fumigation or other methods of treatment to allow the commodities to move freely without injury to themselves or the danger of spreading the pest involved.

General Plan: The research work carried on under this appropriation is under the direct supervision of appropriate subject-matter Divisions, as follows: Fruit Insects, Fruit Fly Investigations, Truck Crop and Garden Insects, Cereal and Forage Insects, Cotton Insects, Foreign Parasite Introduction, Forest Insects, Bee Culture, Insects Affecting

Man and Animals, Insect Pest Survey and Information, Insect Identification, Control Investigations, and Insecticide and Fungicide Investigations. All of these Divisions have their administrative headquarters in Washington or at the Agricultural Research Center at Beltsville, Maryland, except Fruit Fly Investigations. However, with the exception of the work on insect identification, the research is done at field stations situated throughout the United States in localities where the work can be carried on to the best advantage against the particular pests involved. There are approximately 120 such stations distributed throughout the United States. The work program is so coordinated as to provide for cooperation between two or more Divisions, when advantageous. Much of the research is also cooperative with other Bureaus and with the appropriate State Agricultural Experiment Stations or other State agencies.

Progress and Current Program: The following discussion indicates under the various financial projects the present trend of work under the respective programs and outlines briefly some of the recent accomplishments:

1. Fruit Insects

Citrus and other subtropical fruit insects: The red scale is a pest of prime importance to citriculture in California. Investigations of the failure of the standard fumigation procedures are therefore being continued. Resistance to HCN of two stocks of California red scale maintained in the laboratory has continued to increase as a result of fumigations through 22 and 16 generations, respectively. This build-up of resistance indicates that there may be some factor operating other than the elimination of nonresistant individuals by the fumigant.

In an extensive series of small-plot field fumigation tests using a blower-applicator, reasonably uniform average HCN concentrations were obtained with both gastight and untreated canvas tents, but a more uniform distribution of the gas was obtained in the gastight than in the canvas tents, and scale kills were obtained with from one-third to two-thirds the amount of HCN.

Continued work with derris resins in oils for control of the California red scale in California has shown that the effect of the derris is greatly influenced by the emulsifier.

The use of DDT in a light medium oil to control the red scale was tested throughout 1944, but results were much less promising than those reported earlier. Sprays of kerosene plus DDT did not give control but applications of this combination 1-1/2 to 3 months after a regular oil spray gave a considerable reduction in the later infestation. In California, DDT showed promise for use in the control of the citrus thrips.

Experimental work with oil sprays to control the Florida red scale in Florida yielded results which indicated that oils having a high temperature distillation range may be more effective than those having a low distillation range, and that the distillation range of an oil may influence its insecticidal efficiency more than its viscosity, gravity, or unsulfonated residue content.

In Florida, DDT at the rate of 1/4 pound, 1/2 pound, and 1 pound per 100 gallons of water dissolved in No. 2 fuel oil which was then emulsified and diluted to a strength of from 1/2 to 1-1/2 percent, and sprayed on citrus trees, was found to be very effective in destroying the little fire ant and in preventing reinfestation. DDT dissolved in a scale insect spray oil or used as a water suspension, as a dust, or as a tree band, was not so effective. DDT sprays were more effective when applied to the entire inside of the trees than when directed against only the trunk and larger branches; however, when applied by the latter method, the more effective ones controlled the infestation present at the time and prevented reinfestation for as long as two months.

Codling moth: This pest remains the most destructive and costly of the many with which the apple grower has to contend. In 1944, following two consecutive seasons in which weather conditions were unusually favorable for the pest, more than 50 percent of the entire apple crop in some orchards in the 3-brood sections of the Middle West (southern Ohio, Indiana, Illinois, Missouri, and northern Kentucky) was injured by worms. Some growers expended more than $100 per acre for spray materials alone, yet lost substantial parts of their crops. Similar conditions existed in certain eastern orchards.

In 1944, DDT gave a high and outstanding degree of control of the codling moth in tests carried on in New York, Maryland, West Virginia, Indiana, and Washington. This was true despite the fact that the technical DDT available for testing was difficult to prepare for use and prepared formulations were limited as to type and number. Results indicate that from 1/2 to 1 pound of powdered DDT may be equal to 3 pounds of lead arsenate or cryolite for codling moth control; however, where such quantities of DDT were used mite populations often increased to a high level, and in the Pacific Northwest the woolly apple aphid may again become a problem. Some yellowing and dropping of foliage has occurred on some apple trees on which DDT has been used, but heavy mite populations appeared to be largely responsible.

At Vincennes, Indiana, combination sprays containing but 4 ounces of DDT to 100 gallons, with half the usual concentration of lead arsenate or nicotine bentonite, reduced the number of wormy apples to less than half of that resulting from the use of the usual concentration of lead arsenate or nicotine bentonite alone, and gave as good results as DDT, 1 pound per 100 gallons, without any other insecticide. In addition, mite populations did not increase appreciably where such combination sprays were used. Large-scale tests of such mixtures and other DDT programs are being conducted in 1945 in commercial orchards in several areas.

The results of laboratory or small-scale preliminary field tests indicate that several materials, such as kaolin, diatomaceous earth, and gypsum, may be as satisfactory diluents for DDT as pyrophyllite. Much further work is under way in 1945 with various types of formulation and methods of application, including water-dispersible powders, vaporized oil solutions, emulsions of DDT solutions, and dusts, in order to develop the best method of using DDT for codling moth control.

Residues of DDT from the most effective treatments did not exceed 0.10 grain per pound of fruit at harvest in 1944, and in a number of instances were below the tentative proposed tolerance of approximately 0.05 grain per pound of fruit. Preliminary residue removal tests conducted at Vincennes, Indiana, and Yakima, Washington, in cooperation with the Division of Insecticide Investigations, indicated that DDT residues are extremely difficult to remove; dry brushing had but little effect on them and the best washing treatments removed only slightly more than 50 percent.

Tests of dusts for codling moth control in the Hudson Valley confirmed the fact that the addition of 2 percent of a 100 viscosity mineral oil, 10 to 20 percent of processed nicotine bentonite, and, in some instances, lime, to a 20 percent lead arsenate dust increased its effectiveness but not to the point where the dusts were as effective as sprays. A 20 percent phenothiazine dust with 2 percent oil gave promising results, and a 5 percent DDT dust was even more promising. However, at Vincennes, Indiana, natural enemies were affected to a greater extent and mites were a more serious problem when DDT was used in dusts than when it was used in sprays.

The improved tank-mixed nicotine bentonite formula, developed at the Vincennes, Indiana, station, in which Mississippi bentonite is substituted for Wyoming bentonite, has now been adopted as a standard recommendation by the Indiana and Illinois Agricultural Experiment Stations.

At Yakima, Washington, a xanthone formula suggested by the California Experiment Station, which consisted of xanthone, 2 pounds; stove oil, 1 quart; and a commercial spreader (colloidal 77), 8 ounces, per 100 gallons of spray was tested, beginning with the third cover spray, controlled codling moth effectively and also prevented the development of an infestation of the Pacific mite.

The practical value of using a tree-trunk spray containing dinitro-o-cresol to control overwintering codling moth larvae was again demonstrated in two orchard tests in which about 90 percent of the hibernating worms were killed. As a result, such a spray is now being manufactured commercially. Wax and fat solvents contained in this spray are difficult to obtain under present conditions; in consequence, progress was made in developing a satisfactory substitute material. An extension of the use of these trunk sprays indicated that it may be possible and practicable to use them to kill worms attempting to cocoon during the growing season.

At harvest in 1944 the codling moth infestation in the isolated orchard defruited near Kearneysville, West Virginia, in 1942, and not sprayed subsequently, was 50 percent greater than in 1941, and 500 percent greater than in 1943. This indicates that defruiting can be expected to provide only a brief respite from the need for application of a full spray program in areas where conditions favor codling moth development.

Comstock mealybug: An additional 24 orchard infestations of the Comstock mealybug were reported during 1944, making a total of 130 on record from 10 States from Connecticut to Georgia, and Ohio. A number of these new infestations were in the Staunton-Charlottesville to Roanoke area, but the principal center of mealybug activity and the most severe fruit injury again occurred in the Winchester area of northern Virginia. A secondary cycle of mealybug activity appears to have developed in some of the older infested areas in Virginia, but it is much less damaging than the first and there are indications that a state of balance is being attained between the insect and its introduced natural enemies which should prevent or minimize future losses. Satisfactory control is being maintained in northern New Jersey and southern Ohio, and the formerly severe apple infestations in Delaware and southern New Jersey subsided during 1944 as parasitization became effective.

Pseudaphycus sp. was again the dominant parasite in most areas although Allotropa burrelli increased rapidly in Virginia and was more prevalent in Delaware. Both of these introduced species have shown an exceptional ability to persist when the mealybug hosts become scarce, and to extend their distribution rapidly through natural spread.

In 1944, a very dry season, parasites killed 32 times as many adult mealybugs as the mealybug fungus. The active program of parasite colonization under way in cooperation with State agencies in Virginia, New Jersey, Delaware and Connecticut is being continued. During 1944, over 100,000 Pseudaphycus adults were propagated in the laboratory.

Laboratory tests indicated that DDT at 2 pounds per 100 gallons was more effective against newly-hatched mealybug crawlers than other immature stages, and that it had little effect against adult female mealybugs. Satisfactory control was obtained in a heavily infested orchard with 1-1/2 pounds DDT per 100 gallons in sprays directed against first- and second-brood crawlers or against second-brood ones only; however, parasitization was depressed following the spray applications. Adults of the parasite Pseudaphycus sp. were very susceptible to DDT deposits resulting from the use of 1/2, 1, or 2 pounds per 100 gallons. The relationship of control by parasites to control with sprays containing DDT remains to be determined.

Dried fruit insects: "Arsenal" packages of prunes packed for the armed forces did not become infested with the Indian-meal moth, the saw-toothed grain beetle, or the confused flour beetle after being exposed to infestation by these insects for a period of 41 days.

Dosages of 4 cc. of ethyl formate or isopropyl formate applied to "arsenal" packages in the packing line gave incomplete mortality of test larvae, and 5 cc. gave complete kills. As a result, the army specified a required dosage of these formates of 4.5 cc. per carton of 0.52 cubic foot. In preliminary tests in 1945, packing line fumigants were more effective when added to the top of the fruit after it was packed than when added to the bottom of the box before it was packed as has been the common practice. A mixture of equal parts of acrylonitrile and carbon tetrachloride killed all larvae of the raisin moth and adults of the saw-toothed grain beetle at the low dosage rate of 1/4 pound per 1,000 cubic feet for 15 hours at a temperature of from 68 to 82° F. A dosage of only 2 cc. of this mixture killed all test insects and eggs in solid fiber, 25-pound boxes of raisins (0.41 cu. ft.) packed on Government order at a temperature of from 44 to 58° F. No HCN was found in analyses of raisins exposed to acrylonitrile (vinyl cyanide).

Preliminary tests showed that DDT, applied to a cardboard barrier over which saw-toothed beetles crawled to reach raisins, gave about 89 percent control after an exposure of 7 days and all beetles were dead or moribund 3 days after removal from the set-up. When this same cardboard barrier was used again 25 days after the DDT had been applied, an exposure of 10 days killed all beetles.

In the first season's work on control of the fig scale by spraying, good results were obtained on both Adriatic and Kadota varieties with sprays containing 3 or 4 percent dormant oil or 3 percent dormant oil plus 3 percent lime sulfur.

Filbert insects: Sanitation experiments in filbert orchards in Oregon, which involved picking up all dropped nuts and burning them at 6-day intervals from August 9 to September 6, 1944 again gave results which indicated that approximately 95 percent of the filbert worms and filbert weevils which would otherwise have remained in the drops to reinfest the orchards the following year were destroyed.

Fruit insects which are potential pests in Continental United States: This project, conducted at laboratories in Mexico City, Hawaii, and the Canal Zone, has two principal functions. The first is to develop treatments for fruits and vegetables which will kill any eggs or larvae of these pests that the products may carry, thus allowing food crops so attacked, to move to market within the Continental United States or to be imported thereinto without risk of spreading or establishing pests. The second is to study, in their native habitats, fruit insects which would be serious pests should they become established in the Continental United States and thus to have methods available to deal with them.

During the past year studies at the Mexican laboratory have included use of DDT against fruitflies and the citrus blackfly. The recent introduction of the blackfly into Mexico and its spread there is a threat to American citrus, particularly of Texas and California, and

studies on its field control and response to vapor-heat sterilization of fruit are under way. DDT dust was very effective in killing Mexican species of fruitflies in cages and in protecting fruit under such conditions from infestation. Spraying and dusting with the same and similar formulae in the field, however, have not been as promising and indicate possible weathering effects which will be investigated. DDT in field tests in Hawaii against the melon fly attacking tomatoes gave 67 percent control of the mature crop and in cage tests on both the melon fly and the Mediterranean fruitfly complete mortality was rapidly obtained. Studies in Mexico also covered bait traps, fumigation, vapor-heat sterilization of fruit, relation of climate to fruitfly distribution and abundance, and work on plants reported to possess insecticidal properties. Fumigation studies there with methyl bromide resulted in the discovery of an adsorption effect which with some materials resulted in mortality after twenty-three days. At the request of the Brazilian Government a survey of the citrus industry of that country, primarily from the point of view of fruitfly infestation and fruit sterilization was carried out. This survey offered an opportunity to gather other data of interest to the United States.

Grape insects in the East: In replicated field tests to control the grape berry moth at Sandusky, Ohio, summer oil emulsion was again found to be a more effective adhesive and supplement for lead arsenate than rosin fish-oil soap or kerosene emulsion. Likewise, summer oil emulsion plus Bordeaux mixture was much superior to tank-mixed nicotine bentonite with soybean phosphatides when used for the last two applications. In both Ohio and New Jersey, 1 to 1-1/2 pounds of DDT per 100 gallons of spray gave a high degree of control of this insect and may be equal or superior to lead arsenate. In 1945, DDT sprays gave a higher degree of control against the first brood than lead arsenate, but were not so effective against the second brood. In addition, it gave promising results in limited tests, in controlling the rose chafer, the grape rootworm, and grape leafhoppers.

An extension arm placed on the 24" blade of a grape power hoe proved to be satisfactory in cultural control operations. In the cultural system of hoeing out the trellis ridge in the spring, the use of the extension arm throws the removed soil further out into the grape row centers and scatters the soil. This enables row center cultivation or plowing to be performed more satisfactorily.

Japanese beetle investigations: DDT has continued to give outstanding control of the Japanese beetle. In field tests one to three applications of DDT (micronized with an equal quantity of pyrophyllite, and with glue as a wetting agent) at the rate of 1 pound per 100 gallons of spray gave almost complete control of the beetles on peaches, early apples, grapes, blueberries, and a miscellaneous group of ornamental and shade trees and shrubs. Applications after the first spray were necessary only to protect new growth.

Tests with 28 different soils indicate that 25 pounds of DDT (in various formulations) per acre are more effective against third-instar larvae than 1,000 pounds of lead arsenate, that, while DDT was somewhat more

effective in sands than in other soil types, the type of soil seemed, in most cases, to have little significant influence on its insecticidal action, and that so far as can be determined technical DDT has remained unchanged in toxicity to the larvae for a period of 75 weeks in the soil. Technical DDT appears to be as toxic to third-instar larvae in the soil as the purified form; however, in plant growth and productivity tests with lima beans and soybeans early in 1945, technical DDT again affected adversely the growth of both of these crops and the productivity of soybeans, as it did in 1944, whereas as much as 100 pounds of purified DDT per acre did not. Lima beans were not affected adversely by the technical DDT except at the 100-pound per acre level, but soybeans were so affected at the 25-pound level.

In preliminary tests at Moorestown, New Jersey, ethylene dibromide was used as a larval fumigant in corrugated paper boxes and tin cans, and, in emulsion form, as a dip for infested plant balls and for surface applications on soil plots. In all cases, the larvae were killed by very small dosages. Although some plant injury occurred in some tests it appeared that a safe margin may exist between the limits of plant tolerance and larval kill. Since ethylene dibromide solidifies at about 48° F. it was used in combination with ethylene dichloride to produce a mixture containing equal parts of the two materials which could be handled at any ordinary temperatures.

By the close of the calendar year 1944, the cooperative program of distribution of milky disease had resulted in the treatment of more than 43,000 acres at over 66,000 colony sites in 86 counties in 12 states and the District of Columbia; in addition, the Bureau has treated 9,033 acres of turf on 128 Government-owned reservations in 7 states and the District of Columbia. In 1944 alone, 2,257 acres of Government property, largely on Army airfields, were treated by the Bureau, and approximately 7,258 acres in 9 states and the District of Columbia in cooperation with state agencies. This program is being continued with special reference to the treatment of Army and Navy establishments. The results of the milky disease distribution program continue to show marked reduction in the number of beetles emerging from the treated areas.

Oriental fruit moth: Distribution of the oriental fruit moth parasite Macrocentrus ancylivorus has been continued. The new method of producing this parasite from the potato tuber worm was further developed for use under eastern conditions. It was found that breeding is feasible throughout the year and that with a parasitization rate of 60 percent 2,000 parasites, including an 8-fold increase of females, per 10-pound tray of potatoes may be obtained in each turnover. During 1944, 353,000 M. ancylivorus were reared, the majority from the potato tuber worm. During 1944, a microsporidian disease that infects the tuber worm and the parasites produced from it was discovered and steps taken to overcome its adverse effects on parasite production. Shipments of M. ancylivorus and breeding stocks of it and the tuber worm for liberation were made to interested State agencies, as heretofore.

Injury to peaches by the oriental fruit moth was reduced considerably in field plots sprayed with DDT, 1 pound per 100 gallons, in an experiment conducted in cooperation with the New Jersey Agricultural Experiment Station.

Parlatoria chinensis: It has been determined that this introduced scale insect is not a pest of sufficient economic importance in the areas in which it is known to occur to justify a program to attempt its eradication, and that measures developed to effect its control in the field and on nursery stock are adequate to prevent it from injuring plants or being distributed on nursery stock. Accordingly, it was decided that further surveys to determine its distribution more exactly would serve no useful purpose and that the research program could be discontinued. This was done as of February 15, 1945.

Peach insects: Under conditions of rather light infestation, two applications of a spray containing dichloroethyl ether to the ground again gave as good control of the plum curculio as the regular schedule of lead arsenate sprays applied to the trees. In preliminary tests, DDT was less effective than lead arsenate; it caused no injury to fruit or foliage.

The results of extensive experiments conducted in 1944 indicate that propylene dichloride used at one-half the strength recommended for ethylene dichloride may control the peachtree borer effectively without injuring the tree and at less cost than with the latter material. It seems to be especially effective against borers present in the trees at unusual depths.

Preliminary observations and field tests in South Carolina indicated that the tarnished plant bug is responsible for the deforming of peaches and that it may be possible to control it effectively with DDT. One application early in the season of 1945 of sprays containing 1 or 2 pounds of DDT per 100 gallons, or dusts containing 5 or 10 percent DDT, reduced the percentage of peaches deformed by sucking bugs from 42.4 to from 7.8 to 11.8 percent.

Pecan insects: At Monticello, Florida, and at Brownwood, Texas, DDT, 1 pound per 100 gallons of spray, showed promise for pecan nut casebearer control. At Brownwood, also, further progress was made in developing a simpler method than looking for casebearer eggs in the orchard to time spray applications. It appears that it may be possible to recommend that such sprays be applied within 2 to 8 days after 85 percent of the catkins are shed from such common varieties as Burkett, Eastern Schley, or Mahan.

At Albany, Georgia, it was found that injury by the pecan weevil can be reduced about 50 percent by jarring infested trees and collecting the fallen weevils at regular intervals. Here, also, and at Brownwood, Texas, preliminary indications were obtained that DDT or lead arsenate sprays may effect worthwhile reductions of injury by this insect.

Observations and introductory work with the hickory shoot curculio in Louisiana pecan orchards indicate that this insect infests late-developing varieties of pecans to a greater extent than earlier ones, that nearby wild hickories or pecans contribute to heavy populations of weevils in pecan orchards, that the heavier populations are associated with neglected orchards, and that control with sprays containing lead arsenate is not very promising. Because of the increasing importance of the shoot curculio problem, a new station was established in the spring of 1945 at Shreveport, Louisiana, where one man will devote most of his time to this problem.

Relation of insects to peach mosaic disease: The use of sticky board traps was found to constitute a more thorough and less time-consuming method of securing records of the local distribution, seasonal abundance, and host relationships of species of insects suspected as vectors of peach diseases, such as peach mosaic, than manual methods employed formerly. A total of 297 peach mosaic vector tests were carried out with 11 suspect insect species in established test plots near Riverside, California, at Brownwood, Texas, and near Espanola, New Mexico. Preliminary readings on vector experiments initiated in 1944 revealed three cases suspicious of peach mosaic, in each of which certain species of thrips are involved.

Relation of insects to phony peach disease: The use of sticky board traps to obtain information regarding possible insect vectors was a distinct improvement over the manual methods employed formerly. Data collected in surveys for possible vectors of phony peach disease indicate that a small group of twig-feeding leafhoppers very likely includes the vector, and 17 transmission tests were made with the most promising suspect. Final readings have been made on a sufficient number of tests to indicate strongly that phony peach is not spread by soil-inhabiting insects. The importance of maintaining experimental trees in a vigorous growing condition is now recognized as necessary to insure satisfactory results in transmission tests.

Various insects affecting deciduous fruits: DDT showed excellent promise against the pear thrips on prunes in Oregon, both as a soil insecticide and as a spray or dust against the adult thrips on the trees. Soil treatments with calcium cyanamid gave reductions in thrips emergence in some cases, but the results were very irregular. At Poughkeepsie, New York, no fruitflies were reared from the fruit of 4 trees in a previously heavily infested orchard which was sprayed in 1944 with DDT, 2 pounds per 100 gallons. In laboratory and field tests at Kearneysville, West Virginia, all concentrations of DDT from 1/2 pound per 100 gallons upward gave satisfactory control of the pistol casebearer. On the other hand, DDT has appeared to have little or no value in the control of either hibernating adults or nymphs of the pear psylla. Against the apple maggot, results were irregular.

A fourth year's work in the Northwest, in cooperation with a number of State and Canadian agencies, has substantiated the previous work showing that although the use of a heavy mineral oil as a dormant spray often retards the development of pear foliage, and causes the lenticels to swell, neither of these phenomena appears to be harmful.

Some fruit bud killing may occur on the Winter Nelis variety but no permanent injury is done to the trees. The results appear to be conclusive, and this investigation is being discontinued.

2. Forest Insects

Insects attacking forest products: Assistance was given the Forest Service and other owners and managers of timber in connection with the salvage of additional Douglas fir timber on the 1933 Tillamook Burn area in Oregon. Nine representative areas were sampled in cooperation with the Division of Forest Pathology of the Bureau of Plant Industry, Soils, and Agricultural Engineering to obtain data on the degree of insect damage and other deterioration and how the salvageable volume might be determined and best utilized.

Preliminary tests of oil solutions of DDT for prevention of attack on logs by ambrosia beetles have indicated that it may be very useful, but under certain conditions even an 8 percent concentration is not fully effective. Solutions of dichlorodiphenyloxide in kerosene have given about 75 percent protection to sweetgum logs in the Gulf States.

Advice was given to South African authorities regarding the use of pentachlorophenol for treating lumber infested with anobiid and Lyctus beetles. The South African Government now requires that all new lumber be dipped for 5 minutes in a solution of pentachlorophenol before being placed in buildings. The frequent occurrence of powder-post beetle infestations in lumber shipped from the United States had seriously threatened our export trade previous to the development of this control measure.

Insects attacking mature timber: Study of the Engelmann spruce beetle indicates that this beetle may have a 2-year life cycle under certain conditions and that many of the adult beetles have the unusual habit of migrating to the bases of previously infested trees where they hibernate in large numbers beneath the bark around the root collar and lower 2 or 3 feet of the tree trunk. This hibernation habit may have a very important bearing upon the development of effective control measures. A mixture of 1 part orthodichlorobenzene in 6 parts Diesel oil was found to be effective against larvae and young adults in cut logs but only partially effective when applied to standing trees. Tests with DDT emulsion applied to infested standing trees were inconclusive, but laboratory tests indicate that spraying green logs with 1/2 or 1 percent DDT emulsion will prevent attacks and kill most of the beetles when confined in cages.

Completion and analysis of a 3-year study of the effects of various fertilizers and types of root and twig pruning on ponderosa pine in Oregon showed that needle development, as influenced by various treatments, appears to be the best single indicator of tree vigor. These results should be of importance in further studies of tree susceptibility and its application in sanitation-salvage logging

of ponderosa pine. A summary of past studies on the interrelation of fire and insects in ponderosa pine was completed as a basis for future investigations. Considerable progress was made in preparing a general summary of all previous work on the western pine beetle. In California, an outbreak of Ips beetles in recently logged areas has threatened the success of sanitation-salvage logging operations as a means of reducing bark beetle losses. Study of the infested areas had indicated that season of cutting may be important in affecting the development of subsequent Ips infestations.

Insects attacking second-growth timber: Excellent control of the gypsy moth was obtained by applying a solution of DDT from an airplane, using 1 pound of DDT in 1 gallon of liquid per acre. Tests made with several other forest defoliators such as the green-striped maple worm, pine sawflies and white pine weevil gave similar results. Many different spray mixtures containing DDT have been tested with ground or hand equipment in efforts to determine the factors that influence the type of spray deposit and its effectiveness under various conditions.

The cooperative project with the State of Wisconsin and Division of Forest Pathology, BPISAE, to determine relationships of Saratoga spittle bug and the so-called "burn blight" condition in jack pines in the Lake States has been completed. The work indicated that the spittle bug was primarily responsible for the injury. Preliminary tests indicate that DDT is very effective when used for control of the spittle bug. Airplane spraying of a test area was carried out in 1945.

Insect vectors of forest-tree diseases: Further tests with DDT emulsions and solutions applied to living elm trees for preventing crotch feeding by Scolytus multistriatus beetles, which transmit Dutch elm disease, have been very encouraging. A solution of DDT in kerosene, applied as a dormant spray, prevented feeding by the beetles for over 70 days during which period the sprayed trees were subjected to over 12 inches of rainfall. Some of the emulsions used during the foliar season prevented feeding for periods up to 127 days. If similar results can be obtained in large-scale field applications it should be possible to give adequate protection to valuable trees by spraying them once or twice each year. Tests were also made with DDT sprays applied (1) to noninfested wood to prevent breeding of bark beetles and (2) to infested wood to destroy the bark-beetle brood. Freshly cut elm logs sprayed with solutions of 2.5 to 50 grams of DDT per liter of kerosene were exposed to normal weathering for various periods and then exposed to attack by elm bark beetles. None of the sprayed logs became infested although the checks were heavily attacked. Three elm logs heavily infested with larvae of Scolytus multistriatus were sprayed with DDT solutions in kerosene. No beetles emerged from these logs.

The treatment of test plots to determine the feasibility of protecting valuable elms in cities and parks through control of elm bark beetles by sanitation measures and use of trap trees has continued.

On the Morristown, New Jersey, plot 12 diseased trees were removed from the inner 1-mile radius zone and 130 from the second zone in 1943, and during 1944 the corresponding figures were 5 and 52, respectively. A plot at Princeton, New Jersey, is being used to test the value of chemically treated trap trees. A total of 428 low-value trees were treated in 1944 and treated logs were placed at 100 locations where suitable trees for the attraction of the beetles were not available. Examination of this material has not been completed. A third plot was established at Marietta, Ohio, where both the Dutch elm disease and the elm phloem necrosis disease are present. This plot is being treated by sanitation methods, in cooperation with city officials.

Preliminary tests indicate that elm trees can be kept entirely free of sucking insects that may be responsible for transmitting the elm virus disease organism by spraying them with DDT solutions or emulsions. Thus, even though the specific vector is not known it may be possible to protect valuable trees. Determination of the vector or vectors will make it possible to restrict spraying operations to the periods when the insects are active.

The possibility was suggested during the 1944 season that the nursery trees used in transmission experiments thus far may be resistant or immune to the virus disease. A large series of grafting experiments by Forest Pathology have resulted in a very small percentage of transmissions of the disease, much below what is obtained with wild seedlings. The nursery stock was obtained from outside the known disease area. It is therefore planned to repeat many of the tests with trees that are known to be susceptible, especially with the Moline variety of elm.

Spruce budworm: The spruce budworm, which is now destroying extensive forests in Canada and can be expected in the Maine forests in the near future, has in earlier outbreaks destroyed from 50 to 90 percent of the pulpwood over very extensive areas. Last summer the pest appeared in considerable numbers through the Adirondack region and in Vermont presaging a serious outbreak there also. The adopted plan of work emphasized three angles: (1) Application of insecticides from airplanes for protection of valuable stands and possible prevention of spread of the insect; (2) Biological studies of the insect to obtain information that may be worked into forest management practices; (3) Cooperation with the Branch of Research of the Forest Service and with Maine timberland owners in determining the possibilities of applying silvicultural practices to the Maine timberlands for prevention of serious losses. It was determined that DDT is very effective against the spruce budworm although much additional work is needed in developing the most satisfactory formulae for airplane application and determining the lowest dosages that are effective. Biological studies are being carried out in Colorado and eastern New York, although early observations were made in Canada in the provinces of Quebec and Ontario. Study areas have been selected in Maine where cutting practices designed to improve growth conditions

and stand composition are being demonstrated in cooperation with the Forest Service and private owners. Experimental areas were sprayed by airplane in Colorado, in eastern New York in late spring, and detailed observations were made on spraying operations conducted by Canada in Quebec and Ontario. Results were generally very favorable.

Surveys and advice to land-managing agencies: Special attention was given the Engelmann spruce beetle outbreak in Colorado. This devastating outbreak has built up following a heavy blow-down of timber in 1939. About 3 billion board feet of spruce has been killed, about 2/3 of it in 1944 and 1945. As yet, only four national forests are seriously affected: the White River, Grand Mesa, Routt, and Uncompahgre. Surveys in 1944 showed that most of the losses have been on the White River where 7,575,400 trees, containing 1,783,652,000 board feet, or 60 percent of the merchantable volume were killed by the end of 1944. An attempt was made to survey some of the spruce stands from an airplane, but it was found to be impossible to detect infested trees from the air because the foliage does not change color until about a year after attack by the beetles. Surveys for the Black Hills beetle in ponderosa pine and lodgepole pine in Utah, Wyoming and Colorado disclosed several outbreaks where control measures were needed.

It was found that the volume of pine timber killed by bark beetles in California was 10 percent greater in 1944 than in 1943. The most serious increases were in the eastern part of Shasta County near the town of Burney where Ips beetles killed a considerable volume of the residual stand in recently cut-over areas. The western pine beetle also increased in these areas, and it is feared that this may be the beginning of another period of serious losses. A total of 14 bark beetle infestation areas in the State were reported as demanding control action in 1944. Preliminary reports indicate further increase in 1945.

Extensive outbreaks of the black-headed budworm in Washington and the hemlock looper in Oregon were examined, and control operations for the latter were conducted by state authorities under technical guidance by Bureau officers. Over 40 million board feet of timber was killed by the looper in 1944. Salvage operations were recommended for about 6,500 acres of killed timber, and aerial spraying was conducted on about 11,000 acres of heavily infested timber.

Demands have increased greatly for technical assistance in applying sanitation-salvage logging in the Pacific Coast States. In California the work at Black's Mountain has been continued, and additional cuttings have been made by the Forest Service and several logging companies. In Region 6 the Forest Service is formulating a definite policy as to beetle control by sanitation-salvage; the Office of Indian Affairs has undertaken a large-scale test of the method; and several timber operators are considering it as a part of their sustained-yield production program.

During the 1944 season, area hazard surveys were made on the Sisters Area, Deschutes National Forest and on the Kinzua Area, Umatilla National Forest, both in Oregon. Hazard on the 340,000-acre Sisters Area was sampled in a mechanical way by running strips at 1-mile intervals through the remaining virgin pine stands. Some 19,000 trees were classified as to risk. On the 400,000-acre Kinzua Area, a modified road strip method of determining hazard was utilized, with over 27,000 trees rated as to risk. On both areas data were taken regarding past losses.

Termites: Military and housing agencies have been given technical advice in preventing damage by termites to buildings, fabrics, and various types of containers and packaging materials. Information that is being obtained through a large series of tests of soil poisons, fabric treatments, wood impregnations and other experiments is made available as rapidly as possible. A group of five roofed boxlike structures (12' x 12' x 20") comparable to the foundations of buildings were constructed on the Harrison Experimental Forest near Saucier, Mississippi. These are being used in studying the effects of various amounts of ventilation and soil moisture in relation to termite activity. Assistance was given to several of the Army Service Commands in planning and applying control measures where termites were causing severe damage to buildings. At Fort Bragg, North Carolina, several chemical treatments were applied on an experimental basis under Bureau direction.

3. Truck Crop and Garden Insects

Bean insects: The results of field experiments carried on under conditions prevalent in eastern Virginia and western North Carolina show that rotenone dust mixtures are far superior to DDT or any other insecticide yet tested against the Mexican bean beetle. The addition of 2% nicotine as a means of saving rotenone failed of its purpose. Cryolite mixtures containing 40% sodium fluoaluminate was approximately as effective as a 70% concentration when equivalent per-acre quantities of sodium fluoaluminate were applied. The application of rotenone dust mixtures by airplane for Mexican bean beetle control in the Hendersonville, North Carolina, area, was not as effective as when the material was applied with a ground machine, apparently due to the lack of coverage on the undersides of the leaves of the plant where the insects feed. In tests for the control of the bean leafhopper on pole beans, it was found that a DDT dust mixture was highly effective and that this material was much more effective than any of the rotenone-sulfur or rotenone-nicotine-sulfur mixtures which were included in the experiment.

Cole crop insects: The investigations on the control of cabbage caterpillars have continued to emphasize the need for materials which might be used as substitutes for rotenone and pyrethrum. These investigations have shown that the new chemical, DDT, which is being developed as an insecticide is more effective against the several kinds of cabbage caterpillars that attack cabbage than any other material yet tested. Information still is needed to develop a satisfactory formula

and determine the residue hazard. Other features of this work were that a dust mixture prepared from the ground root of the plant, Derris malaccensis, was as effective against the green caterpillars which attack cabbage as rotenone mixtures containing 1/2% rotenone and that the efficacy of pyrethrum may be decidedly increased by incorporating with the pyrethrum a synergist known chemically as piperonyl cyclohexenone. This latter discovery is of particular importance as this will result in the use of the so-called pyrethrum marc, a by-product of the processing of pyrethrum to provide material for the control of mosquitoes and flies by the armed forces.

Pea weevil: As a result of tests of 38 insecticides and combinations of insecticides, it was indicated that DDT may be a satisfactory substitute for rotenone dust mixtures in pea weevil control or will, at least, supplement our limited supplies of this material. The field work with cryolite as an insecticide for the control of the pea weevil has been developed to the point that it, although costly, can be recommended if rotenone supplies are not sufficient to meet the needs of the pea industry or if the early promise of DDT is not fulfilled.

Pea aphid: The studies on pea aphid control revealed that 0.3 of a pound of rotenone per acre was superior to smaller dosages. Eleven different dust mixtures were tested and the results showed that the most effective were derris dust mixtures containing 0.75% rotenone. A dust mixture containing 5% DDT was found to be superior to a mixture containing 0.5% rotenone, the DDT plots yielding at the rate of 1,517 pounds of shelled peas and the rotenone plots 859 pounds per acre.

Potato insects: The investigations on potato insects include the development of measures of control for the potato flea beetles affecting potatoes in the West and aphids which affect potatoes in the East, especially those aphids which disseminate the leafroll disease in potatoes grown for seed stock. In addition to these studies an investigation of the potato psyllid in relation to crop damage is being carried on in Nebraska and adjacent states. Work on potato flea beetles showed that a dust mixture containing 55% sodium fluoaluminate was more satisfactory than other concentrations of this material. Observations made in three fields where cryolite dust was applied by airplane showed results less effective than when the cryolite was applied by ground equipment. The work in Maine on the control of aphids to prevent infection from the disease, leafroll, showed that while the insecticide applications reduced the aphid infestations, they did not reduce the occurrence of the leafroll disease.

Insects affecting seed production: The investigations on this problem involve insecticidal tests for the control of plant bugs on sugar beets grown for seed in Arizona, New Mexico, California, and Utah, and a study of the cabbage seedpod weevil and its control in the cabbage seed-producing areas of Washington and Oregon. Work on the onion thrips is carried on in California and in Idaho in cooperation with the State Experiment Stations. Insecticidal studies on the Lygus bugs which attack sugar beet seed crops showed that DDT in the dust form was far more effective against these insects than the pyrethrum-sulfur dust mixtures which were formerly used for the control

of these pests and that the results of this preliminary work warranted large-scale field operations with DDT dust mixtures. The effect of the DDT on the build-up of aphid populations on the sugar beet seed stock remains to be determined. The laboratory tests, having for their objective the discovery of a satisfactory insecticide for the cabbage seedpod weevil, did not yield any very promising results. This insect was found to infest from 17% to 94% of the seedpods. The onion thrips work in Idaho was handicapped by cool, rainy weather in April and June which retarded the development of the thrips. However, a large number of field tests were conducted with various insecticidal materials and while the differences between the various materials tested were not clear-cut, a 5% DDT-pyrophyllite dust mixture was superior to the other insecticides tested. In California similar results were obtained.

Beet leafhopper: The work on the beet leafhopper has been directed primarily towards the development of a means of reducing beet leafhopper populations in beet fields in order to prevent the dissemination of the curly top disease, especially on beets in the seedling stage. Work has also been conducted on desert surveys during the fall, winter, and spring to determine the condition of the leafhopper and its wild host plants because these factors affect the density of the spring movement of the leafhoppers to the cultivated fields. From the limited number of tests conducted with various formulations of DDT, both as dusts and as sprays, the results show that this material may be developed into a very satisfactory remedy for the protection of seedling beets from infection by curly top through the feeding of leafhoppers. From the surveys of the desert areas during the fall of 1943 and spring of 1944 the indications were that leafhopper populations that moved into the cultivated areas would be large. However, because of unfavorable weather conditions which affected the food plants of the leafhopper, the spring generation of the pest did not develop as expected in southern Idaho. As a result of this light infestation of the leafhopper the curly top infection in beans and beets was of little consequence. From the surveys which have been made in the Big Horn Basin area of Wyoming there is positive evidence that the insect overwinters successfully in this area and when conditions are favorable, the populations of the insect may be such as to cause some damage from curly top to plantings of non-resistant beets. In Utah surveys of the beet leafhoppers spring breeding areas showed that the movement of the leafhoppers from the desert to the cultivated areas during the spring of 1944 would be small. Consequently there was only minor damage to beets, beans, and tomatoes from the curly top disease.

Sweetpotato weevil: Insecticide studies which have been conducted on the sweetpotato weevil include poisoned baits and the application of insecticides to the crop in the field. No satisfactory synthetic bait has been developed. Calcium arsenate proved to be the best insecticide for field use. Treated areas yielded 560 pounds more sweetpotatoes free from weevil than did the untreated areas. However, it required 10 applications of calcium arsenate to bring about this result and it is questionable whether such a large number of treatments would be an economic practice. Work with vine cutters and vine shavers, as a means

of facilitating removal from fields of all potatoes and roots which may harbor the sweetpotato weevil, has shown this equipment to be practicable. Also these vine cutters and vine shavers will facilitate the use of tractor-powered mechanical diggers for harvesting the crop.

Tobacco insects: The work on tobacco insects was conducted in the dark fire-cured tobacco growing areas of Tennessee and the flue-cured areas of North and South Carolina. In North Carolina the results of the experiments designed to develop a combination blue mold-flea beetle spray for treating of the plant beds showed that either calcium arsenate or cryolite could be added to a standard fungicide without lessening the beneficial effects of either material. A 5% DDT dust mixture was found to be one of the most effective materials used on the plants to protect them from flea beetle damage in the plant bed prior to their being pulled for setting in the field. Basic copper arsenate also gave promise of being a useful remedy. In experiments to develop a substitute for lead arsenate for hornworm control, it was discovered that cryolite was more toxic to the tobacco hornworms than paris-green-lead arsenate mixture, especially in the latter stages of the worms' development. In the Florence, South Carolina, area, in comparative tests in a search for substitutes for lead arsenate for tobacco hornworm and flea beetle control the most satisfactory hornworm control and the highest yield of cured tobacco were obtained from the plots treated with basic copper arsenate. The most effective method of killing green June beetle larvae in tobacco plant beds was by the use of a bait consisting of 4 pounds of barium fluosilicate and 25 pounds of wheat middlings. In the dark fire-cured area, dust mixtures containing 70% cryolite applied at the rate of 25 pounds per acre proved to be effective against hornworms on burley and dark tobaccos. The work with stored tobacco has been concerned largely with the development of substitutes for pyrethrum in the control of the tobacco moth in open storage houses. A 5% DDT-oil spray in laboratory tests was toxic to the tobacco moth and the cigarette beetle. Two new fumigants were tested against the tobacco moth and cigarette beetle in normal atmospheric fumigant chambers. Both of these materials, trichloro-acetonitrile and acrylonitrile-carbon tetrachloride, gave 100% mortality of the larvae of the cigarette beetle and the tobacco moth at dosages of 6 ounces per 100 cubic feet. Experiments to determine the effect of the redrying process on tobacco insects show that this process for leaf tobacco killed all stages of the cigarette beetle and the tobacco moth. This information indicates that leaf tobacco, when first placed in storage, will be free of insect infestations. Assistance to the Commodity Credit Corporation was rendered throughout the year. Processing plants for leaf tobacco were inspected. Prospective warehouses for storage were examined and appraised as to the possibility of applying control measures for the tobacco moth or cigarette beetle in case tobacco in such warehouses becomes infested. Tobacco warehouses were inspected and weekly records of insect infestations in these warehouses were obtained. Advice and recommendations on insect control were given when and where necessary.

Tomato fruitworm: The results of the experiments to ascertain the most efficient combination of insecticides to use for fruitworm control in California now provide a sound basis for recommendations to the grower. These results have shown that a dust mixture containing 70% of cryolite is superior to mixtures containing from 35 to 50% of cryolite even when the same poundage of cryolite per acre was applied. In Ohio on the other hand it was found that undiluted calcium arsenate was superior to cryolite dust mixtures. The work with DDT against the tomato fruitworm has been of a preliminary nature but judging from the results of these preliminary laboratory and field tests DDT shows a greater toxicity to the tomato fruitworm than any material tested to date and with the proper formulation of an insecticide and the determination of the proper dosage per acre this material promises to supplant other insecticides for the tomato fruitworm.

Vegetable insecticides: A total of over 100 different insecticides or combinations of materials has been tested during the past year. With the exception of the results obtained from the use of DDT no other material showed any exceptional possibilities as a future insecticide. In limited field tests with 30 aerosol formulations containing DDT, derris resins, or nicotine, the DDT formulations yielded more satisfactory results than either the derris resins or nicotine. One of the outstanding features of the work with DDT is its use in the field in the aerosol form. When applied under a shallow hood satisfactory kills of aphids, thrips, and leafhoppers and several other insects on vegetables were obtained. The hood served to concentrate the aerosol or fog as it was released from the high pressure container. During the early season of 1945 large scale field plots were treated with aerosol for pea aphid control. The results of this work are especially encouraging and it appears that this simplified method of treating peas for aphid control will supplant the present cumbersome methods of spraying and dusting and at a cost which will be lower than either dusting or spraying.

Wireworms: At Ventura, California, the work which has covered a five-year period on the relation of winter cover crops to wireworm infestations has shown that the plots planted to barley were most favorable to the development of wireworms and that the wireworm populations were lower in the plots where the cover crop was plowed under before the adult females had emerged in the spring. This indicates that the females select soil covered with green vegetation in preference to fallow soil as a place to lay eggs. The results of this experiment show that it is inadvisable in wireworm-infested areas to plant cover crops and, while this may conflict with soil-conservation programs, the situation can be partly remedied by plowing under the cover crop early in the spring. Experiments which have been conducted with chemicals applied to the soil for the control of wireworms show dichloropropane-dichloropropylene and ethylene dibromide to be effective in killing wireworms. However, the success of these materials from a practical standpoint is dependent upon the cost of their effective application to the soil. This requires expensive equipment. DDT was tested in the laboratory and out-of-door insect cages and when thoroughly mixed with the soil at the rate of 32 pounds to the acre,

showed a high mortality to wireworms. However, further research on the effects of this material on plant growth will be necessary before it can be determined as to the place that this new insecticide will have in wireworm control. The studies on naphthalene during the past season showed that of thirteen different brands and kinds of pure and crude naphthalene having over 90% purity, practically the same percentage of kill of wireworms was obtained when the particle size of the material was reduced to less than one millimeter.

4. Cereal and Forage Insects

Chinch bug: Serious chinch bug infestations developed in 1944 in parts of Illinois, Indiana, Kansas, Missouri, Nebraska, North Carolina and Oklahoma. Satisfactory controls were secured where barriers of dinitro-ortho-cresol dust or creosote were used. Field surveys showed a very high over-wintering population in the Central States, with prospects for serious damage in 1945, but weather adverse to chinch bug development in the late spring and summer of 1945 restricted the damage to local and minor infestations.

DDT in dust mixtures was found very effective in dust barriers and in very heavy dosages when dusted directly on bugs infesting sweet corn, popcorn and oats. Heavy dosages of dust mixtures containing sabadilla and ryania also were effective when applied directly on the bugs. Two barrier materials, 8 percent dinitro-ortho-secondary-butyl-phenol and 8 percent dinitro-cyclohexyl-phenol, both in pyrophyllite as a carrier, and with 5 percent oil, were about as effective as 8 percent dinitro-ortho-cresol dust with 5 percent of oil and gave complete protection to corn. The dinitro-ortho-cresol dust gave complete control wherever used, even though it was 3 years old. Dust barriers containing from 1 to 4 percent dinitro-ortho-cresol were effective against the young bugs, but not against the nearly mature ones. An improved "Hydroformers Bottoms," a by-product of oil refining, tested as a barrier against migrating chinch bugs was quite satisfactory and can be recommended in lieu of coal tar creosote.

Ecological studies, tests of contact insecticides and repellents for use in control of infestations in crops, and tests of barrier materials with particular reference to diluents, concentrations, and rates and methods of application, are being continued.

Corn earworm: In 1944 heavy populations developed on late corn in central and southwestern Illinois, central Missouri and Nebraska. Moderate damage to corn was reported from Georgia, Tennessee, Kentucky, and New Jersey and only light damage from New York. Corn was damaged severely near Logan, Utah and Phoenix, Arizona, and infestation was heavier than usual in sweet corn at Weslaco, Texas. Soybeans in Virginia and North Carolina and peanuts in Georgia were severely damaged. Earworm populations were generally much lower in the Central States in 1945.

DDT in mineral oil gave almost perfect control of the earworm in both green and maturing stages of sweet corn and hybrid seed corn. Pyrethrum, styrene dibromide and dichloroethyl ether in oil all gave

less control than DDT, which was the only insecticide that protected seed corn until harvest. Equally good results were secured from the use of mixtures containing oils of 80/90 or 120/125 seconds Saybolt viscosity. Dent corn R 30, which is markedly resistant to earworm damage, is being used in commercial crosses and resistant sweet corn 471U6 has very promising commercial prospects. A number of field corn lines adapted to southern localities show promise of carrying earworm resistance.

Investigations are being continued to find and utilize varieties of corn resistant to the earworm and the characters related thereto, and to test new insecticides, carriers and methods of application to ears to reduce costs and adapt treatments to practical use on canning corn in addition to market and seed corn.

European corn borer: In 1944, the European corn borer was found for the first time in Kansas, Nebraska and Tennessee and in a considerable number of counties outside territory previously known to be infested in 10 other states. Estimated losses to corn caused by the borer in 1944 totaled about $22,700,000, averaging over 20 million in field corn and over 2-1/2 million in sweet corn. In the eastern part of the infested area, infestations were generally lower in 1944 than in 1943, while farther west in the Corn Belt, especially in Illinois and Iowa, the borer was much more abundant in 1944. In the Mississippi River Valley, the proportion of the early season borers that produced moths for the second generation ranged from 47 percent at Milan, Illinois to 89 percent at Canton, Missouri. With unfavorable weather for borer development in 1945, only limited spread of the borer was reported, principally in Minnesota and Kansas, and the general population level is probably lower than in recent years.

Additional borer-resistant lines of corn have been discovered and those previously found are being utilized in the corn improvement program, either directly as inbreds or parents in breeding programs to intensify resistance or transfer it to susceptible but otherwise desirable agronomic lines. This work is being carried on in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering and various State agencies. It has been determined that the primary point of larval establishment in the whorl stage of plant growth is in the wet basal areas of the partially unfurled leaves and that the presence of pollen in the tassel buds and in the axils of the leaves and similar places after shedding is associated with high rates of larval survival.

DDT provided good control of the borer in various spray and dust formulations applied with ground or aerial equipment. Spray formulations of Ryania speciosa were as effective as the standard rotenone spray. Preliminary tests indicate that effective insecticidal controls can be obtained with aerial as well as ground equipment. A comparison of nozzles delivering a solid cone with those giving a hollow cone spray pattern gave an increase in borer reduction of 15 percent with a 7 percent lower dosage of spray with the solid cone type.

Field collections of borers in Massachusetts, Connecticut, and New Jersey in cooperation with State agencies provided almost 500,000 adult parasites of four different species, which were released during the season in 13 States throughout the infested area. In 1945, more than 233,000 adult parasites, including 5 different species collected from the above three States, and one laboratory-reared species provided through the cooperation of the Division of Entomology of the Canadian Department of Agriculture, were released in 14 borer infested States. Parasitism of the overwintering borers by four imported parasites continues high in the Eastern States and a pupal parasite continues to maintain its status on summer borers near Boston, Massachusetts. Parasitism by species that attack the borer larvae of the summer generation was considerably higher than that of overwintering borers, ranging from 15% at Burlington, New Jersey to 43% at Taunton, Massachusetts in 1944.

Grasshoppers: Grasshopper populations were generally low in 1944 although severe local damage occurred in small grains, corn and alfalfa. Severe damage to field margins of fall-planted wheat was reported from Kansas, Wyoming and Montana. Grasshopper injury reduced the quantity of alfalfa seed harvested in many States, especially in parts of Nebraska and Wyoming. Populations generally remained at low levels in 1945.

In Arizona, renovation and light cultivation of alfalfa fields, removal of a spring hay crop, and burning over of fields apparently reduced hopper populations.

In tests of DDT dusts and sprays it was found that only heavy applications gave effective control of grasshoppers in dense stands of alfalfa. Dust preparations of dinitro-ortho-secondary-butyl-phenol were more toxic to hoppers than dinitro-ortho-cresol, both being effective but also severely injurious to foliage. Dust preparations containing piperonyl cyclohexanone gave some indication of toxicity to grasshoppers and good results were obtained with benzene hexachloride and di (para-methoxy phenyl) trichloroethane. Dry bran-sawdust baits were more effective than wet baits in field tests in alfalfa in Arizona and grassland in California, sodium arsenite and sodium fluosilicate being equally effective as the poisonous ingredient, and sodium fluoride and ammonium fluosilicate less so. All baits were more than twice as effective in thin alfalfa as in dense stands. In Arizona during 1945 baiting results in tall alfalfa were materially improved by increasing the proportion of bran to sawdust in the bait and increasing the quantity of sodium fluosilicate or using the standard quantity of sodium arsenite. Benzene hexachloride gave good results when used as a bait in laboratory cages.

Studies are being continued to determine the factors responsible for fluctuations in grasshopper abundance, including weather conditions, parasites, cultural practices and baiting, and to develop and improve baits, sprays and dusts for grasshopper control in tall succulent vegetation such as seed alfalfa.

Hessian Fly: Hessian fly infestations at harvesttime, 1944, were generally low throughout the winter-wheat belt, although moderate to heavy infestations developed in southern Nebraska, north central and northeastern Kansas, southern Wisconsin and southwestern North Dakota. Harvesttime infestations in 1945 were light to moderate except for heavy infestations in Kentucky, Tennessee, southern Illinois and southern Indiana. In California, Big Club 43 and Poso 42, two wheats being increased for commercial release, continued to maintain their resistance to fly infestation. Advance toward commercial release of wheats highly resistant to hessian fly as well as diseases was made in the wheat breeding program in cooperation with Department and State Experiment Station wheat breeders. Development of commercially desirable fly-resistant wheats comprises the major investigations in progress for control of this insect.

Insects affecting legume seed crops: Insect injury to the alfalfa seed crop in Maricopa County, Arizona in 1944 approximated $326,000. The alfalfa seed production in Millard County, Utah was one of the lowest on record, due more to adverse weather conditions than to insects. The acreage of hairy vetch for seed in Oregon has been reduced from about 125,000 to 50,000 acreas principally because of losses resulting from infestations of the vetch bruchid.

Outstanding control of Lygus bugs in seed alfalfa was secured with dust treatments with DDT. Results were less satisfactory with sabadilla and poor with pyrethrum. In Millard County, Utah honey bees were found to collect considerable pollen from alfalfa plants, indicating that they are responsible for much of the cross-pollination essential for successful production of alfalfa seed.

DDT dust was more effective than rotenone dust or a calcium arsenate-sugar-water bait spray against the vetch bruchid, and gave excellent control of heavy infestations. About 85 percent of the weevils in vetch seed were found to be killed by mechanical injury during threshing.

Insects attacking forage crops: Aphid populations in 1944 were generally low on alfalfa in the Antelope, San Jose and Sacramento Valleys in California and on fall (1943) annual legumes sown for seed in Oregon. Severe outbreak of the velvetbean caterpillar developed in the south central and southeastern States on peanuts, soybeans, velvetbeans and cowpeas. Severe damage to corn by flea beetles and much wilt was reported in northwestern Ohio and in parts of Indiana during the later summer of 1944.

DDT gave good control of potato leafhopper on peanuts and alfalfa, the tobacco thrips on peanuts, and the lespedeza webworm on lespedeza. Cryollite was also effective for controlling the lespedeza webworm. Alfalfa plants growing on alkaline soil supported greater populations of aphids than plants in the same field growing on more acid soil. Liming of soil resulted in a large increase in aphid populations and the calcium content of aphid-susceptible plants was found to be considerably greater than in resistant plants. Rooted alfalfa cuttings of a number of field selections of the variety Ranger (A 136) showed a high degree of aphid resistance in the greenhouse.

Emphasis is being placed on the development of alfalfa varieties resistant to the pea aphid in cooperation with Federal and State plant breeders, cultural and insecticidal methods of control of plant-bug damage to alfalfa grown for hay and seed, insecticidal control of the potato leafhopper on alfalfa and peanuts, and insecticidal control of thrips on peanuts.

Insects attacking stored grain and grain products: Tests in a commercial flour mill showed that fumigation of machinery units every three weeks held the insect infestation at a low enough level to insure the production of insect-free flour, at a relatively low cost. In tests of various chemicals as possible substitutes for standard fumigants likely to be scarce due to war conditions a mixture of equal parts of acrylonitrile and carbon tetrachloride was found satisfactory for fumigation of milling machinery. Carbon tetrachloride alone or mixed with various proportions of ethylene dibromide, and trichloroethylene, gave promising results as grain fumigants. Flour stored in the wooden warehouse of a small country mill became infested in one week and the infestation increased with length of storage. Enriched flour was not more attractive than non-enriched flour to stored-product insects but was more conducive to their multiplication.

In an investigation of a long series of chemical dusts for treatment of seed stocks to prevent insect damage, Magnesium oxide dust mixed with the seed at a rate of 1 ounce per bushel or a dust containing 3 percent of DDT in a suitable carrier, applied at the rate of 1/2 ounce of the mixture per bushel of seed gave effective and inexpensive long-time protection against insect infestation. The DDT dust protects seed of any moisture, but the effectiveness of the magnesium oxide decreases as the moisture content of the seed increases above 12 percent.

Under controlled conditions little activity of grain infesting insects occurred below 70° F. At 85° F. and above, longevity and reproduction was progressively reduced. Little breeding occurred in grain of less than 11 percent moisture content but reproduction increased with moisture content. Information being obtained in these studies are basic to the utilization of heat, cold and fumigants in stored-product insect control.

Studies showed that sandpapers as food package wrappings did not prevent penetration of insects but that emery cloth did. Of package wrappings coated or impregnated with a series of chemicals to keep out insects, DDT, acrylamide and a trichlorobutyramide were highly effective. Di (para methoxy phenyl) trichloroethane appears to be an effective repellent when used to impregnate paper wrappers. Certain special treatments of rice rendered it less attractive to insects and, with some of the treatments, less subject to infestation.

Among different management practices tested for control of insects in Ever-Normal-Granary type steel bins the following have prevented infestation: (1) Two annual fumigations, one in August and one in October; (2) Fumigation once annually in September; (3) Turning, cleaning and fumigating annually in September; (4) Storage in steel bins with white walls and roofs which reflect the heat and keep the grain cool.

Sprays containing 5 percent or less of DDT dissolved in refined deodorized perosene, or in water suspension or emulsion, and applied to walls and woodwork of grain bins, warehouses and mills gave good control of weevils and other insect pests of stored grain and cereal products crawling on or burrowing into the walls or woodwork.

Mormon cricket: Although Mormon crickets were still in outbreak numbers in 1944 in sections of California, Idaho, Nevada, Oregon and Wyoming, where several thousand acres of range grass were destroyed, crop damage was negligible. Infestations in general were low in 1945, although it is anticipated some control will be necessary in Nevada in 1946.

Ammonium fluosilicate was as effective as sodium fluosilicate in bran baits. Those containing more of the coarse sawdust gave better control than those containing more of the fine material. Wholewheat flour - sawdust baits did not give consistently high kills under all conditions.

Due to reductions in extent of severe infestations of this insect resulting largely from intensive and effective baiting in recent years, attention is now being given mainly to location of and ecological studies in restricted hold-over areas with a view to preventing widespread outbreaks originating in these areas.

Sugarcane insects: An estimated loss of over $3,000,000 was caused by the sugarcane borer in Louisiana in 1944. The sugarcane beetle was somewhat more abundant than for the past several years but was not very injurious. In 1944 the yellow sugarcane aphid caused heavy injury in some undusted fields as well as in some fields that were dusted with cryolite for control of the borer but was much less numerous in 1945. In 1944 and 1945 the West Indian sugarcane fulgorid was found for the first time in several counties of southern Louisiana and Mississippi, though not in injurious numbers. Much of the stand of late planted sugar sorghum in test fields in Louisiana was destroyed by the lesser cornstalk borer. The West Indian sugarcane mite was also found present in several Florida sugarcane fields.

As a result of continued variety tests conducted in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering and State agencies, one additional variety of cane resistant to the borer has been recommended to the plant breeders for use in breeding resistant cane. Eight promising varieties not yet released for commercial use appear to be resistant to borer injury. The most practical method of disposing of borers overwintering in summer-plant cane is to shave off the shoots just below the soil surface, cover them in the middles with 2 or 3 inches of soil and leave them undisturbed until after first generation emergence, or until cultivation is necessary. Cryolite dust provided better control of the borer than castor bean extractives, dinitro-o-cresol-ethyl-ether and potassium fluosilicate. Although sodium fluosilicate gave good control of first generation borers, it caused severe injury to some cane varieties. An increase of one percent in sugarcane joints bored

caused a loss of 77 pounds of sugar per acre. The best control of the yellow sugarcane aphid was secured with applications of a 4 percent nicotine dust.

Investigations now being emphasized include varietal resistance of sugarcane to the borer; cultural control of the borer by clean-up of infested debris and roguing deadhearts; improvements in the use of cryolite applied with aerial and ground equipment; tests of new insecticides for control of the sugarcane borer; distribution, abundance and importance of sugarcane insects throughout the southeastern States; relation of the control of insect vectors to spread and control of sugarcane diseases; and effect of flame cultivation on insect abundance and mosaic spread.

White grubs: May beetle flights were small in Indiana in 1944, with no apparent increase in Brood A. The abundance of Brood B apparently was reduced considerably in 1945.

In laboratory tests applications of the fumigant DD mixture at 60 cc. per square yard by injection or on soil surface gave good grub control but were injurious to the crop. Applications of a water suspension of DDT in pyrophyllite containing 5% of DDT and 5% DDT emulsion to the soil surface and washed down with water did not give a high grub control.

Observations are being continued on cultural control procedures for use in pastures, and on laboratory and field tests of soil insecticides, supplemented with ecological studies relating to crop damage and cultural control.

White-fringed beetle: The overwintering populations of the beetle grubs were from 1/2 - 2/3 as numerous in 1944 as in 1943. Almost 10,000 additional acres infested by the beetle were found in the Gulf Coast States amd include infestations adjacent to the previously known infested areas and some new isolated infestations in North Carolina.

DDT dusts and sprays were effective as both stomach and contact poisons against beetle adults and as soil insecticides against the larvae. Kerosene containing 2 and 4 percent of DDT was effective as an ovicide. Potassium fluosilicate appears to be about as toxic to beetle adults as cryolite. Neither stable manure nor commercial fertilizers applied to corn affected larval survivals or reduced crop damage appreciably. The results of propagation and dissemination of parasitic nematodes in areas infested by beetles do not suggest that they will become a major factor in beetle control, or any practical way in which their effectiveness can be increased.

In the continuing program the biology of the beetle in relation to its control by cultural practices, and tests of new insecticides, are being emphasized.

5. Cotton Insects

If cotton is to survive postwar competition with synthetic fibers and foreign production and remain an important crop in the United States, the average annual loss of over 10 percent of this crop from insects must be greatly reduced. Research to discover, develop and demonstrate better methods of cotton insect control affords an opportunity to reduce the cost of production and improve the grade of lint and seed. The annual expenditures for cotton insect research are less than one-tenth of one percent of the average annual toll of over $230,000,000 that insects take from the cotton farmer.

Research has helped greatly in reducing insect losses but much remains to be done. If the only accomplishments of cotton insect research were the development of the use of calcium arsenate for boll weevil control and the use of sulfur for flea hopper control, the results in increased yields of cotton would repay each year all the expenditures that have been made for research on cotton insects. Many progressive farmers testify that the use of control practices developed by this Bureau has saved them thousands of dollars and increased their yields by hundreds of bales in a single season. However, none of the cotton insect problems have been completely solved. Many have not been investigated and in each of the 19 cotton-growing states there are still many problems that need attention.

Emphasis has been continued on lines of research to simplify and improve the known methods of cotton insect control and to develop new methods that will be more economical and have greater appeal to growers. Examples of some of the accomplishments of the past year are:

Boll weevil: Boll weevil conditions changed rapidly in 1944 from prospects for severe damage to an effective check by hot, dry weather early in the season that reduced the damage far below average. The boll weevil is such an important cotton pest for which growers spend so much for control that a slight improvement or reduction in cost of control contributes greatly to reducing the cost of producing cotton.

Many growers in the Southeastern States continue to mop cotton with a mixture of calcium arsenate, molasses and water for boll weevil control despite the fact that previous tests have shown this method is not effective. Mopping tests were conducted on a field basis instead of small plots in 1944 on 39 fields at 5 localities in South Carolina, Georgia, Mississippi, and Louisiana. The average gain in fields mopped at Florence, S. C., was 29 pounds of seed cotton per acre as compared to 268 pounds in fields that were mopped and later dusted with calcium arsenate. In the other three states there was no average gain from mopping. Citrus molasses, a by-product of the juice industry, and "Curbay," a by-product of cane molasses used for alcohol, were as effective as molasses when substituted for it in the mopping mixture.

Calcium arsenate was developed for boll weevil control and although 60 to 75 million pounds are used annually on cotton, it causes the aphids to build up following its use, and reduces the growth of cowpeas and

other leguminous soil-improving crops in certain types of soils. Chemists and manufacturers are continually trying to improve its chemical and physical properties to overcome these objections and each year tests are made with specially prepared experimental calcium arsenates, containing various percentages of arsenic, adhesives, and "safening" materials. None of the materials tested so far have been found superior to commercial calcium arsenate for weevil control. Basic copper arsenate is nearly equal to calcium arsenate and causes less soil injury but costs about three times as much. Iron arsenate (scorodite), magnesium arsenate, potassium fluosilicate, barium fluosilicate, and cryolite were inferior to calcium arsenate. DDT in the formulations tested to date has not given weevil control nor increased the yields. However, further tests with other DDT formulations and the many new synthetic insecticidal materials that are being developed should be continued.

Bollworm investigations: DDT is the most effective insecticide ever tested against the bollworm in both laboratory and field experiments. The mortality of third-instar larvae from dusting at the rate of 16 lbs. per acre of 4% DDT was 84% as compared to 62% for calcium arsenate; 65% for lead arsenate, 56% for cryolite, and 73% for basic copper arsenate, each at 8 lbs. per acre. A water spray at the rate of 1.28 lbs. actual DDT per acre caused 100% kill of large larvae; at 0.64 lb. DDT, 89%; at 0.32 lb., 66%; and at 0.16 lb. DDT, 45%. DDT applied as a spray remained effective longer than when applied as a dust.

In small plot experiments the gains in yield from 2 applications of DDT were 158 lbs. seed cotton per acre from 1% dust; 154 lbs. from 2% dust; 238 lbs. from 4% dust; and 320 lbs. from 8% dust as compared to 273 lbs. from calcium arsenate. In a large field experiment 4 applications of 4% DDT gave an increase of 736 lbs. of seed cotton per acre. The special advantage of DDT for bollworm control is that large worms can be killed; failure to accomplish this has been the great drawback to other insecticides.

In experiments on reduced dosages it was indicated that the degree of control was better from heavier dosages of cryolite and calcium arsenate. Among the substitute materials tested, it was found that calcium and lead arsenate combined in the process of manufacture, calcium arsenate with adhesives, and a special calcium arsenate made from the waste products of a dye factory were about equal to regular commercial calcium arsenate. Scorodite, an ore containing iron arsenate that occurs abundantly in the West, was ineffective and micronized potassium fluosilicate was less effective than calcium arsenate for bollworms.

Cotton aphid investigations: Control of the aphids that often build up following the use of insecticides for boll weevils and other insects continues to be one of the most difficult problems in cotton insect control. Evidence is accumulating that the loss from aphids following the use of arsenicals often offsets the gains from control of a light to medium infestation of other insects and discourages the more general adoption of control measures.

Unfortunately DDT in the formulations tested does not control the cotton aphid as it does some species of aphids. The ladybird predators which are important in holding down aphids were reduced about 67% by 4% DDT and 75% from 5% DDT dusts. The full effect of DDT on the biological complex of cotton fields has not been determined. In some experiments DDT caused no apparent increase in aphids while in others the increase was equal or greater than from calcium arsenate. A mixture of calcium arsenate and DDT caused larger increases in aphids that either material used separately. Nicotine added to DDT gave about the same aphid control as when added to calcium arsenate.

Additional details were obtained on the most effective way of using nicotine in combination with calcium arsenate to prevent the increase of aphids. In laboratory and field tests nicotine sulfate, free nicotine, fixed nicotine, and zinc nicotinyl fluosilicate were about equally effective per unit of nicotine. Afternoon applications of mixtures of calcium arsenate and nicotine gave better aphid control than morning applications but the morning applications gave better weevil control. Midday applications were less effective for both insects.

Nicotine and rotenone continue to be more effective for the cotton aphid than any of the other insecticides tested. Supplies of both materials are short and expensive for a low value per acre crop like cotton and a synthetic substitute is badly needed.

In cooperative studies with the Mississippi Agricultural Experiment Station and the Bureau of Plant Industry, Soils, and Agricultural Engineering, a comparison of the aphid populations on 65 inbred lines and 22 commercial varieties of cotton used in the selections for aphid resistance showed that considerable progress had been made and that productivity and quality of lint are being maintained. Detailed studies were made of 10 strains of inbred lines of cotton used in the hybridization program and in the first generation hybrids to determine the inheritance of hairiness of leaves which is a factor in aphid resistance. Samples from 150,000 self-fertilized bolls were examined for percentage of lint, uniformity and strength of fibers to determine those which were to be retained for future work. Development of aphid resistance or tolerance is slow but promises good returns.

Cotton flea hopper and related insects: Heavy emergence from hibernation and early season examination of fields through the Cotton Insect Survey indicated that flea hoppers would cause serious damage in some areas. The laboratory at Port Lavaca, Texas, was reopened for the season to compare DDT with the recommended insecticides for flea hopper control. In general it was found to be more effective.

DDT caused a high mortality of tarnished plant bugs in cages but the results in the field were erratic and not as good as expected.

Insect-collecting machines for control of cotton insects, particularly the cotton flea hopper and related pests, are being sold to cotton growers. The apparatus consists of a fan mounted on the front of a

tractor that blows a strong current of air across the rows and "whips" the plant against a screen in contrast to many types of machines that suck the insects instead of blowing them from the plants. Devices of this kind collect the injurious and beneficial insects indiscriminately. In a sample containing 8,278 insects collected from 1/20 acre at Waco, Texas, 89% of the specimens were injurious to cotton or other crops. Insects migrate back into the machine-treated plots within a short time and the effect was not as lasting as that from insecticides. However, the gains in yields where the machine was run 4 or 5 times at weekly intervals showed the machine did more good than harm and it appears machines of this kind might be used advantageously early in the season while the cotton is small.

Pink bollworm investigations: The increase in populations in the lower Rio Grande Valley and spread of the pink bollworm to 16 new counties in Texas increased the hazard of establishment of this insect over the entire cotton belt and stimulated research on control measures for immediate use in reducing populations.

DDT gave the most encouraging results of any insecticide ever tested against the pink bollworm and is the first material of sufficient promise for large scale tests. Eight dust applications caused reductions of larval populations of 53% from 2½% DDT-pyrophyllite; 78% from 5% DDT; 62% from 2½% DDT-22½% pyrophyllite-75% cryolite; and 44% from cryolite. In another test with 10% DDT the reduction in population in the part of the field receiving 4 applications was 41% and in the part receiving 8 applications the reduction was 94%.

Moths caged on plants heavily dusted with DDT caused no infestation. Newly-hatched pink bollworms were extremely irritated but not immediately killed by crawling over a dust film of DDT, indicating that the reduction in populations may have been due to killing the moths before oviposition occurred.

Based on the excellent preliminary results an extensive control experiment with DDT was undertaken in 1945. Approximately 500 acres comprising most of the cotton in Presidio Valley proper is being dusted with DDT by airplane and a similar acreage in the lower Rio Grande Valley will be dusted and sprayed with various formulations of DDT by airplane, power and hand dusting and spraying equipment. It is also planned to treat 200 or 300 acres in the El Paso Valley with airplanes and ground machines to determine the most effective and economical formulation and method of application in each section. A special feature of the spraying experiments is the use of DDT solutions or emulsions in finely-atomized form applied at the rate of three gallons per acre by airplane or a new power sprayer developed by the Bureau. This type of spray has not been used previously on cotton and a great deal of experimentation will be required to develop a formulation of DDT that is toxic to the pink bollworm, non-injurious to plants, and economical. The 1945 experiments are sufficiently large in scale to reduce the interference of moths migrating from untreated fields and to obtain some information on the effects of DDT on the plants, other insects, wild life, and the soil. It is also hoped to determine the feasibility of using DDT on a large-scale control program.

In view of the recent increase in abundance of the pink bollworm in the El Paso Valley, a laboratory was established at Fabens in November 1944 to study the factors that are responsible for the buildup. Preliminary experiments indicate that very few pink bollworms survive the winter in bolls on standing stalks and that the most favorable situation for survival is within bolls on the soil surface. This is opposite to the findings in the Brownsville area and emphasizes the importance of studying the conditions in each section before making recommendations for control.

The expansion of the work with insecticidal control and the wartime restrictions on travel have made it necessary to postpone the breeding and colonization of parasites until conditions become more favorable. Over two million parasites belonging to ten species have been reared and liberated in Texas, Mexico, and Puerto Rico.

Plant bugs affecting irrigated cotton: The plant bugs and stinkbugs remained in the cotton fields in 1944 longer than usual and caused serious reductions in yield and grade of irrigated cotton. The gains from dusting with DDT were outstanding and field tests in Arizona in which DDT was applied by hand dusters, power dusters, and airplanes indicate better results than the mixtures of arsenicals and sulfurs that have been developed and extensively used in recent years. On small plots dusted 7 times with 4% DDT the gain was 1,018 lbs. seed cotton per acre or 42% more than the checks as compared to 13% to 26% gains from four arsenical-sulfur combinations. A heavily-infested field dusted 6 times with DDT by airplane produced 920 lbs. more seed cotton per acre or 97% more than the check field and 30% more than the field treated with paris green-sulfur mixture. Plots dusted 7 times with DDT by power duster produced a gain of 551 lbs. as compared to 396 from paris green-sulfur and a loss of 22 lbs. from DN. Cage and field tests indicated 4 or 5% DDT is more effective than lower concentrations and that mixtures with sulfur caused a quicker kill than mixtures with inert carriers. Additional work is being undertaken in cooperation with growers to determine the best formulations of DDT, dosage, and its effectiveness against the various sucking insects.

Promising results against the plant bugs were also obtained with sabadilla-sulfur dusts.

Investigations of various cotton insects: Information and help were furnished growers on the control of many cotton insects. Several hundred acres of cotton were being defoliated by the cabbage looper which the growers mistook for the cotton leafworm and could not control with the usual insecticides used for this insect.

Extensive experiments showed that DDT would not control the leafworm.

The tobacco and onion thrips which cause serious damage to cotton in local areas every year were controlled by DDT. No satisfactory control for thrips on cotton was previously known. Growers were assisted in controlling grasshoppers that were causing considerable damage to cotton in several States and cutworm and armyworm outbreaks in many local areas.

Gamma benzene hexachloride: Preliminary experiments conducted during 1945 with a new insecticide, gamma benzene hexachloride, indicate that there is a possibility that this material may be of greater value for the control of insects that attack cotton than any of the insecticides that have previously been used. For the control of the boll weevil and cotton leafworm it may be equal or superior to calcium arsenate; for the control of the cotton aphid it may be equal or superior to nicotine; for the control of the cotton flea hopper, Lygus bugs and stinkbugs it may be more effective than DDT or any of the other insecticides that have been used. The experiments with gamma benzene hexachloride against cotton insects have just been started but the results have been so striking and the possibility of helping the cotton industry so great that this work should be expanded as rapidly as possible.

6. Bee Culture

Advisory service on beekeeping and pollinating insects: Service of an advisory nature has been furnished to the beekeeping and allied industries in an effort not only to make honey production profitable and attractive in itself but to insure that every facility is given to promote the use of bees and other insects in pollination. This service is accomplished through correspondence, meetings, news releases, bulletins and personal contact. It includes the diagnosing of bee diseases from samples submitted from all parts of the country, arsenical determinations of bees suspected of being poisoned, the issuance of permits for and the examination of all importations of adult bees as required by the Act of Congress of 1922, etc.

In excess of 9,800 beekeeping inquiries were answered and 1,015 samples of adult bees and brood suspected of diseases or poison were diagnosed, an increase of 18 percent over last year. A Department Circular "Productive Management of Honeybee Colonies in the Northern States," and 5 articles in outside journals were published; 697 bibliographical references were compiled; and information was given to a number of feature writers for national publications. A large number of questions on beekeeping were answered for other Government agencies.

Bee Breeding: This project has to do with the fundamental knowledge of bee breeding and genetics. Progress in developing superior strains of honeybees has been very slow. One reason for this has been the impossibility of obtaining controlled matings. Within recent years, however, the technique of artificially inseminated queens has developed to the point that, by the use of multiple inseminations, queens as productive as naturally mated ones can be produced. This technique gives tangible hope for the development of strains resistant to disease strains safe to handle from the standpoint of stinging, strains that will fly under adverse weather conditions, a characteristic especially needed for pollination, etc.

Evidence was obtained from two generations of sibling individual matings that the sex determination mechanism may be the same in the bee as in Habrobracon. In each case one-half the brood in the first generation was highly viable and one-half poorly viable. In the second generation, sisters of poorly viable brood produced one-half poorly viable and one-half highly viable brood.

Two inbred lines resistant to American foulbrood were continued by sibling matings and crosses made between the two lines. All matings were by artificial insemination. Colonies headed by the inbred queens showed a little more resistance this season than colonies similarly headed last year, and the cross-mated queens were again all completely resistant. The inbred queens and some of the hybrids produced brood of poor quality and did not develop strong colonies. A few of the hybrids were outstanding in both brood quality and production.

In past seasons queens artificially inseminated at Baton Rouge have rarely started laying sooner than 30 days after emergence. On giving 2, 3, and 4 inseminations of 2.5 cu. mm. of semen at 2-day intervals during the first 10 days after emergence, using CO_2 as an anesthetic, the time between emergence of the queen and her initial egg-laying was reduced to an average of 15.3 days. Of 72 queens inseminated by this method, 76 percent started laying.

Queens and drones were reared and mated artificially in a greenhouse in winter in Wisconsin, thus demonstrating that for certain purposes a bee breeding program can be carried on actively during 12 months of the year.

Diseases, poisoning and other abnormal factors affecting bees: Diseases of brood and of adult bees as well as poisoning of bees cause an annual loss to beekeepers in excess of $4,000,000 annually. The loss of such bees means a curtailment in the production of honey and beeswax, but an even greater monetary loss results through reduced pollination of crops which are dependent on insects for seed and fruit production.

The benefits to be derived from having exact control over the mating of queens and drones through the use of artificial insemination was strikingly demonstrated in the American foulbrood resistance studies. In 34 colonies headed by artificially mated queens from 2 inbred and cross-bred resistant strains, only the brood of 4 inbred queens of one strain showed any sign of disease and these recovered, making the season's record for all colonies 100 percent resistant, a figure not closely approached in the case of naturally mated queens. European foulbrood was again present in colonies headed both by naturally and artificially mated queens. One hundred and seventy-five queens of resistant stock were distributed to State agencies.

While the results are not yet conclusive, tests continue to indicate that the honeybee has some self-protection against infected honey through ability to sift out spores of B. larvae (American foulbrood) in its honey stomach. Further work continued to indicate that, in

culture media, pollen initially retards spore germination of B. larvae and slows down its vegetative growth but then subsequently speeds up both spore formation and vegetative growth. Dextrose added to culture media apparently does not stimulate spore germination very much, but noticeably stimulates vegetative growth, and leads to an abnormal development that more or less inhibits spore formation.

It has been discovered that the causative organism of American foulbrood produces a substance that is highly destructive to many other disease producing germs somewhat comparable to the action of penicillin. Inhibition has been obtained by the American foulbrood antibiotic against Brucella melitensis, Brucella abortus, Brucella suis, Aerobacter aerogenes, Escherichice coli, Staphylococcus aureus, Bacillus alvei, Bacillus orpheus, and bovine and human strains of myobacterium tuberculosis, in petri dish cultures. It is not extracted or destroyed by treatment with ethanol, methanol, butanol, ether, acetone, pyridine or chloroform. It does not dialyze through a colloidin membrane. Its potency is not lost when scale suspensions are pasteurized for 10 minutes at 65° C. Autoclaving at 15 pounds for 30 minutes completely destroys it. A flash milk test for field use for American foulbrood was developed.

No evidence of the existence of latent Nosema disease was found in a small scale check at the Wyoming laboratory. A test indicated that the germicide 8 hydroxyquinoleine sulfate had little or no effect on Nosema. Winter packing of colonies inoculated with Nosema proved ineffective against the disease. Losses in Wisconsin from Nosema were lighter than usual, because a mild winter made frequent flights possible. Fifty-six percent of 158 packages showed Nosema, with its presence probable in the case of 11 percent more.

Work was continued on the effects of commercial application of insecticides on honeybees and other pollinating insects. Over 850 samples, mostly plant blossoms, were received from State authorities in Utah for arsenic determination. The highest arsenic trioxide content for blossoms was found in samples from Salt Lake County. This has been ascribed to the presence of smelters in that county. Relatively high amounts were found in samples from Weber, Utah, and Davis Counties, and at times in those from Boxelder and Cache counties. This may be attributed, in part at least, to the drifting of the smelter smoke, although there was also fruit and vegetable spraying and dusting.

It was found that a hive exposed to sulfur-paris green dust applied at the rate of 15 pounds per acre from a plane flying 15 feet above the hive did not kill the bees. That the effect of insecticide poisoning may not become evident for 2 or 3 months was shown by the fact that poisoned pollen was found in a hive 9 weeks after being collected. Poison dusts were found to have drifted more than 2 miles as evidenced by deposits found on petri dishes although bees collected 1-1/2 miles from a dusted field in line with the drift did not contain abnormal amounts of arsenic. Bees collecting in fields adjoining a dusted field contained lethal amounts of arsenic. In Arizona bees gathered lethal amounts of arsenic from cotton 16 days after it had been dusted.

The interrelationship between bees and flowers, including studies on nectar and pollen: During the past 25 years, the population of native pollinating insects in the cultivated areas has seriously declined. This situation has been made worse by increasing the acreages of crops that require insect pollination. It thus appears that the maintenance of a vigorous beekeeping industry is at least a partial answer to the serious decline in seed production. Investigations are now being concentrated on the use of bees in the pollination of alfalfa.

Cooperative studies showed that in Utah honeybees are main pollinating insects of alfalfa, outnumbering native bees on this plant 1,000 to 1. It was also found that only bees in search of pollen, and not those in search of nectar, are effective alfalfa pollinators. Of great importance to the problem, therefore, is the finding that while alfalfa is exceedingly attractive to honeybees as a source of nectar, it is much less attractive both to them and to wild bees as a source of pollen than are sweet clover, gumweed, thistle, chicory, corn, sunflower, white-flowered dodder, and other competitive plants.

Although leaf cutting bees are of prime value as alfalfa pollinators, the studies showed the individuals to be so widely dispersed and so little concentrated in any one area that their collective efforts cannot be depended upon in the pollination of the commercial seed crop. Nomia was found in abundance only near its nesting places and so is not of importance throughout any wide area. Observations showed the average number of flowers tripped per minute by medium and small sized leaf cutters, Nomias, and honeybees to be 9.5, 9.7 and 6.7, respectively. The average for certain large sized leaf cutters was 14.8. The honeybee was found to make up for its lower tripping rate by working 11 hours per day, while leaf cutters and Nomias work but 8.

Results, thus far, indicate that honeybees collect alfalfa pollen only when the plant is not too succulent and that drier fields of alfalfa attract more pollen gatherers than do wet fields.

During the bloom of fruit trees, about 75 percent to 80 percent of a colony's pollen-gatherers confined their attention to fruit trees, judging by the percentage of fruit pollen caught in a pollen trap. In tests in Wisconsin, honeybees pollinated red clover in open fields only when other pollen-producing plants were not competing for their attention.

Management of bees for the production of bee products, including studies on the behavior and physiology of bees: The objective is to develop methods for the evaluation of various lines of breeding stock with respect to honey production, pollination, wax production, and the production of package bees, and to compare lines of available commercial stock in the above respects. Improvements in methods of apiary management and devising and testing beekeeping equipment comes within the scope of this project. Much of the uncertainty in beekeeping stems from inclement weather early in the spring when bees are unable to fly regularly for pollen and nectar, which results in breaks

in brood rearing. This in turn prevents colonies from reaching maximum population at the beginning of the major honey flow. A method has been developed at the Madison laboratory of feeding pollen and soybean flour in such a manner as to make brood rearing practically independent of weather conditions. It has been possible to bring colonies into such early breeding as to enable the production not only of a maximum honey crop but of package bees as well. Through the use of this method it is possible for a honey producer or for a queen or package bee producer to prepare his colonies so as to meet predetermined shipping shcedules and to plan for definite honey flows. Further refinement of this method and its application should bring about highly important developments in beekeeping in many parts of the country.

Experiments during the year showed that feeding pollen and soybean flour to unprotected colonies in winter produces better results in successful wintering and in colony development early in the spring than does the generally accepted method of heavily packing colonies for winter without supplemental packing. A two-queen system used to build up colonies for a late honey flow gave double the amount of brood found in single-queen colonies and triple the amount of honey. A method has been developed whereby as many as 37.7 pounds of package bees were produced last season by a single colony, with an average of 14.6 pounds for 10 test colonies. This is nearly twice the average commercial yield. Labor and material costs are reduced by the method which involves feeding sugar sirup by spraying it on the combs to induce early brood production instead of giving it in feeders. The season's work, in conjunction with that of past years, indicates that changes should be made in present standard beekeeping equipment to permit quicker ripening of honey and to eliminate heavy lifting by keeping the hive closer to the ground, if full advantage is to be reaped from two-queen colonies.

In production tests involving 11 lines of stock, colonies known to be hybrid from their color stood highest, raising the question of hybrid vigor. The value of large populations for maximum honey production was strikingly demonstrated, in view of the exceptionally poor season. Certain colonies showed pronounced brood-rearing capacity. Studies on the production of beeswax were interfered with by insecticide poisoning but in gneral it was found that the wax produced is in proportion to the honey collected.

7. Insects Affecting Man and Animals

Household insects: A number of mothproofing tests were conducted on fabrics and yarns in cooperation with the Naval Clothing Department, The Procurement Division of the Treasury Department, and the Federal Trade Commission. Of special interest are the results of attempts to eradicate lice on goats and impart moth resistance to mohair by dipping the live goats in a solution containing DDT a few days before they are sheared. From preliminary tests it appears that mohair sheared from animals which had been dipped in a solution of 0.2 percent DDT was made fairly resistant to fabric-eating pests. When these tests

are repeated, it is possible that there will be a means of effectively treating the living animals for lice with one dipping and at the same time obtain protection of the mohair and wool from insect damage in storage.

It was also learned that DDT sprays are of value in the control of clothes moths and carpet beetles in stored wool.

Many severely infested kitchens, cheese processing plants, meat establishments, warehouses, hospitals, barns, and Federal dormitories were treated with DDT dusts and sprays for the control of cockroaches. While the results by the several workers have been inconsistent, it is believed that 10 percent DDT dusts are more effective against all species of cockroaches than are the DDT sprays, and that successful control of these pests depends fully as much on the proper application of the treatment as upon the material used.

Lice and grubs affecting livestock: The capillate louse was first found in the United States in 1910. Since then it appears to have spread widely and become a serious pest, especially in the Midwestern States. Little is known of its life history or of the most effective control measures. The short-nosed cattle louse is a widespread species and does not yield satisfactorily to any of the standard dips or sprays now employed. A combination dip consisting of cube and sulfur and developed a few years ago gives good results for control of the motile forms of this species. Since rotenone-bearing powders are scarce and unavailable in many places it is necessary to continue the search for other treatments. DDT, which was first tested in the laboratory during the 1943-44 season and in field tests during the season of 1944-45, appears to be the most promising material ever tested for the control of cattle lice. Since this material, like rotenone, is not an ovicide, considerable amount of work is needed to develop a formula that will eradicate all stages of the various cattle lice with one treatment.

Preliminary tests with dusting apparatus have shown that this method of applying insecticides for the control of cattle lice is promising in cold weather, when many stockmen do not wish to wet the hair of the animals. The successful development of such a dust will fill one of the greatest needs of the owner of small herds of animals.

Cattle producers and meat processing plants were awakened to the fact that the cattle grub takes a heavy toll of the finished carcass at the time when the nation has the greatest demand for more beef and leather. This insect in the adult stage sometimes causes stampedes of range cattle that result in injuries and loss of weight of the animals. Later, in the larval stage in the animal, it results in trimming the most valuable loins, at an average loss of more than $3.50 per animal. As the grubs drop from the animals, they leave holes through the hide. One third of the hides produced in the country are thus damaged. This situation brought demands on the Department to develop and demonstrate control methods.

In order to extend as far as possible the limited amount of rotenone that was available in this country, research was designed to produce rotenone dusts and sprays of maximum efficiency. Considerable progress was made on the development of more efficient dusts made of rotenone-bearing roots of cube. They have given results similar to those obtained last year with ground derris in tripoli, pyrophyllite, and frianite, all of which are greatly superior to sulfur as a diluent. Dust mixtures containing these diluents are compact, flow easily from a dust can, and readily go down through heavy winter coats of hair to the skin to contact and kill the grubs. The newly developed dust mixtures are also less irritating to the respiratory system of the operator than the sulfur mixtures formerly used.

Spray tests made with high pressure sprayers revealed that wettable sulfur in the old spray formula is needless, and according to commercial operators of sprayers, is causing trouble with the spray machinery during the freezing weather. It was found that a simple cube powder suspension in water is superior to a cube powder suspension containing wettable sulfur for killing both 2nd and 3rd stages of cattle grubs.

Rotenone is still the only material that is known to be effective for killing cattle grubs.

Methods of protecting military personnel against insects: A Liaison Officer from this Bureau spent part of his time in cooperation with the offices of The Surgeon General of the U. S. Army and of the U. S. Navy, and with the Corps of Engineers, U. S. Army. Upon invitation, he visited camps and posts along the Atlantic and Gulf Coasts where he inspected and advised on methods of control for mosquitoes, flies, bedbugs, cockroaches, and other insect pests. His lectures were followed by demonstrations, and were attended by Medical and Sanitary Officers of the Service Command. Several hundred officers and enlisted men have been in attendance at these lectures and demonstrations during the past year.

Mosquitoes: Tests have been made with several formulations of DDT against mosquitoes which reduce the production of crops and livestock through their annoyance to man and animals. Although DDT sprays are entirely effective against adult mosquitoes in rice growing lands and for the adults of salt marsh mosquitoes when applied by means of an airplane at the rate of two quarts per acre, such rates of application are not sufficient for control of their larvae. Larger quantities applied to mosquito breeding places before rains occur and induce hatching have shown some promise of control, but the variable results are not fully understood. In laboratory tests against certain pest mosquitoes in the Pacific Northwest, the liquid formulations of DDT were found to be much more effective against larvae than were formulations of DDT dusts.

Studies on the distribution, abundance, taxonomy, biology, and control of the mosquitoes of the northwestern states and Alaska are well underway. This information has long been needed by mosquito

control agencies in that region. Heretofore, several species of mosquitoes in the Northwest have been impossible to identify without larval or male specimens. In our present study, characters have been discovered in females of the genus Aedes which will facilitate accurate identification of the species that are commonly found in that area.

Screwworms and blowflies: The screwworm is one of the major pests of cattle, particularly in the South and Southwest, and in some years, as in 1943, it spread over the greater part of the United States. It breeds only in the living tissues of warm-blooded animals, principally domestic animals. All wounds or abrasions are subject to attack. When wounds become infested the maturing screwworms quickly increase the sizes of the wounds and kill the animals if proper treatment is not administered. Some deer and other injured game animals become infested each season by this pest. The loss of domestic animals is estimated to be about 10 million dollars annually and is certainly much greater during bad screwworm years.

One of the common predispositions of screwworms in cattle is caused by hornflies. As a result of the bites of hundreds or even thousands of these blood-sucking flies on preferred feeding areas injuries are produced that provide an excellent condition for screwworm invasion. In addition to predisposing cattle to screwworms, the hornfly is in itself a major pest of cattle throughout the country and is responsible for loss of blood, flesh and milk. There is an urgent need for a spray or dip that will kill all flies alighting on a treated animal, and one that will give protection for a considerable period after application.

Since rotenone and pyrethrum sprays are no longer available commercially, it was necessary to search for substitute materials. A number of new materials have been tested and two of these have given good results, in both laboratory and preliminary field tests. These are a mixture of bornyl thiocyanoacetate and fenchyl thiocyanoacetate and DDT. The former has been found to be practically as good as pyrethrum as a toxicant for the hornfly, and DDT was indicated to be far superior to either pyrethrum or rotenone for controlling this pest. In fact, DDT has shown such excellent results in preliminary field tests that it is thought to be possible to control hornflies throughout the season with relatively few treatments with this material.

Through the use of field surveys, full advantage was taken of the value of the previously developed Smear 62. New infestations of the pest were promptly located and eradicated or brought under control. This is especially important in areas where screwworms do not occur normally each year, because in these areas the livestock owners are not acquainted with the seriousness of this pest and know little or nothing about its control.

Ticks affecting man and animals: Ticks as pests of man and livestock and as carriers of various diseases constitute a serious problem. Field tests with DDT spray for the control of the black legged tick were planned with two objectives in view: To determine whether the promising results obtained one year ago could be duplicated on a larger scale, and to determine the duration of the period of protection provided by a satisfactory spray.

The results confirmed those obtained a year ago and further indicated that one pound of DDT per acre, applied early in the season, would eliminate the ticks for the remainder of the active season. Laboratory observations on rotenone sprays for clothing indicated that certain slow-drying preparations would kill ticks picked up on the clothing for several hours after spraying.

The use of DDT for the control of the brown dog tick, a species infesting homes and dog kennels, gave high kills when used either as dusts or sprays in yards and within homes.

DDT sprays have also shown promise in control of the winter horse tick. In one experiment in which 175 horses were involved it was shown that horses sprayed twice during the tick season with a solution containing 0.8 percent DDT were protected against this tick for one entire season.

8. Insect Pest Survey

The Insect Pest Survey receives reports on insect conditions monthly or oftener from about 280 collaborators in addition to members of the Bureau. These serve as the basis for preparation of summaries of current information on the more important insect conditions throughout the United States. The summaries are distributed to State workers for their use in planning control operations, estimating needs for control materials, and advising farmers and county agents of impending outbreaks. The reports are placed in the permanent file and with supplemental information obtained by a review of literature are used in directing quarantines and control operations in subsequent years. During the fiscal year 1945, there were received and filed 23,000 reports on domestic insects (20,000 provided through cooperation of the Division of Foreign Plant Quarantines in connection with a special survey around ports), and 700 reports on foreign insects, bringing the total number of reports on file to over 453,000. Records on 80 genera and 200 species not previously included were added to the domestic file.

Approximately 120 requests for information on survey matters were filled, including the preparation of 19 distribution maps. Six summary statements and 1 annual summary on insect conditions, and 6 Special Supplements were issued.

9. Identification and Classification of Insects

During the fiscal year 1945, identifications were made and reported for 59,492 different insect samples contained in 30,184 lots received from other units of this Bureau, and from the Army, Navy, Public Health Service and other Federal agencies; from agricultural experiment stations or colleges of every State, Puerto Rico, Alaska and Hawaii; from individuals, private agencies and pest-control operators; and from foreign governmental agencies and institutions engaged in insect control. More than 800 letters were prepared in reply to requests for specific information concerning the classification of various insect groups, for aid in problems in scientific nomenclature, for distributional and host data for species or groups, and for assistance in the review of manuscripts pertaining to insect taxonomy.

In addition to the identification for the Army and Navy of about 6,000 samples of insects and mites involved in human health problems or recovered from aircraft, direct assistance or instruction in insect classification has been given many officers of both branches of the service. This included aid in the preparation of keys to insect pests, especially mosquitoes, occurring in islands of the Pacific occupied by the armed forces.

Twenty-four manuscripts, totaling 891 pages, on the classification of insects and mites were completed and submitted for publication. They are designed to make possible more exact identifications in the groups treated. Included is one manuscript of more than 300 pages on "Flies that Cause Myiasis in Man."

10. Foreign Parasites

In the field work in South America during 1945 emphasis was placed on the collecting and rearing of parasites of the cotton boll weevil and the vegetable weevil for shipment to the United States. A total of 28,874 adults of Triaspis vestiticida Vier., a boll weevil parasite, were obtained from material collected in Peru, and were forwarded for colonization in Texas and other states. Vegetable weevil parasites forwarded from Uruguay comprised 3,009 Porizon spp. and 244 Triaspis sp.

In continuation of cooperation with the Puerto Rico Agricultural Experiment Station, several shipments of natural enemies were made from Brazil to that island for use against the sugarcane borer and green coffee scale. These included 9,350 parasites of the sugarcane borer of 5 species and 1,469 parasites of the coffee scale of two species.

In furtherance of the cooperative work with state experiment stations, shipments of Trichopoda pennipes L. were forwarded to Washington and Utah, and the vegetable weevil parasites imported from South America were forwarded to the California Agricultural Experiment Station for rearing and field colonization.

Cooperation with foreign organizations consisted of the forwarding, with the cooperation of other divisions of the Bureau, of cultures and spore dust preparations of the milky disease organisms, Bacillus popilliae Dutky and B. lentimorbis Dutky, to Australia for use against white grubs, a consignment of an oriental fruit moth parasite, Macrocentrus Roh., to Brazil, and of 4 species of mealybug parasites to Russia.

A new project, started in November, 1944, relates to the biological control of the Klamath weed in California and adjoining states. This weed has become very destructive and more than 100,000 acres of range land in northern California has been rendered useless for grazing purposes. Similar conditions exist in Australia, and the importation of insect enemies from Europe has shown promise of checking the pest. Three of these enemies, Chrysolina hyperici Foerst., C. gemellata Rossi, both of which are leaf feeders, and Agrilus hyperici Crentz., a root borer, were imported in considerable numbers from Australia. Feeding tests were conducted on a series of crops and have been completed with C. hyperici. The first field releases of this species were made in May 1945.

The parasite receiving station at Hoboken, New Jersey, was closed in September, 1944 for an indefinite period.

11. Control Investigations

Materials and methods of applying them for control of insects by fumigation: The studies on oriental fruit moth, made in cooperation with the California State Department of Agriculture, were terminated at the end of the fiscal year of 1945. Fumigation schedules for larvae in fresh fruits were developed for five temperature levels between 40° and 80° F. and for eggs that might be associated with fruit at 5 temperature levels between 50° and 70°. The effect of cold storage alone on larvae in fruit was determined. Extensive tests with overwintering larvae in an attempt to lower the present recommendations for the precautionary treatment of nursery stock indicated that a reduction cannot be made with safety. Larvae from eastern and western sources (California and New Jersey) were compared in these tests, and found to react similarly. The tolerance of fruits was also studied. No injury occurred in fumigation of summer maturing fruits. Fall apples going into cold storage were uninjured when fumigated before storage, or after 6 weeks storage. An intolerant period during the first 6 weeks of storage was evident in the varieties tested.

Extensive tests on the reaction of apples to fumigation schedules applied under the Japanese Beetle quarantine were carried on in cooperation with the Agricultural Experiment Station of Delaware. Further development of fumigation schedules for products suspected of carrying dormant egg clusters of the gypsy moth permitted the fumigation of 105 freight car loads of Christmas trees and greens, saving an estimated 262 man days of inspection and $22 to $31 per car in handling costs.

The factors governing tolerance of camellia plants when fumigated with schedules recommended for white-fringed beetles were studied and several handling practices recommended to reduce possible plant injury. Provisional fumigation schedules for hay and peanuts, possible carriers of white-fringed beetle eggs, were also developed and recommended. Further studies on soil fumigants, atmospheric fumigation schedules for nursery plants, and dips for small seedlings were carried on.

Methods for applying insecticides: Further adaptation of heat-generated aerosols to the control of agricultural pests was carried out, and tests with a generator developed for the armed forces were made against larvae of the gypsy moth infesting forest areas in New England, with promising results. The development of this method of dispersing insecticides for military uses; and the new types of generator designed for this purpose, make possible much more rapid progress in this field than would have been possible otherwise.

Tests to determine the effect of insecticidal materials: In the search for better insecticides or substitutes for critically short insecticidal materials, the gamma isomer of benzyl hexachloride (1, 2, 3, 4, 5, 6-hexachlorocyclohexanone called 666 for short, has been found to be highly toxic to a number of insects. The gamma isomer of 666 is more toxic to certain insect pests than DDT and less toxic to others.

Insects that attack growing crops were used in making 1,658 tests with 1,296 samples to determine if they possessed insecticidal action; 88 materials showed toxicity to these insects. In cooperation with the Eastern Regional Research Laboratory 3,124 tests on plant-feeding insects were made on 1,882 samples that contained nicotine. Two materials combined with nicotine were highly toxic and 2 new nicotine compounds were shown to be more toxic than nicotine.

Eight hundred sixty-four samples were evaluated by 1,604 tests of sprays on houseflies; 19 materials were toxic and 14 acted as synergists with pyrethrins. On housefly larvae 1,604 tests were made on 864 samples; 12 were more toxic than borax. Forty-seven samples of powders were tested against roaches. Little difference in toxicity between four finenesses of sodium fluoride powder was found. The small difference favored the finer powder.

Toxic effect of insecticides on insects: Studies have been made on the mode of action of DDT and results indicate that some of the characteristic symptoms can result from action of the poison on the nerves without the central nervous system being involved. Similar nervous symptoms can also be produced by a number of other compounds. Tentative conclusions have been drawn regarding possible relationships between chemical construction and toxicological effects of the DDT molecules. This compound can penetrate various regions of the integument of the housefly and one fly can be killed by a ten-millionth of a gram applied in oil to its back. DDT in certain solvents may remain fluid for long periods when applied as drops to various surfaces. These studies contribute to a background of fundamental information on the insecticidal action of DDT.

12. Insecticide and Fungicide Investigations

During the fiscal year 1945, there were published approximately fifty scientific articles or pamphlets which made available to the public the results of research by the Division of Insecticide Investigations on insecticides and fungicides. Nine United States patents covering new insecticides or fungicides, improved methods of preparation, etc., were granted to members of this Division, all of which were dedicated to the use of the public.

Much attention was again devoted to insecticide problems of the armed forces and to the alleviation of still existing scarcities of insecticide materials.

Chemical analysis of miscellaneous compounds tested as insecticides: Analytical and advisory service was continued for the various Divisions of this Bureau. Approximately 1,000 samples of insecticide materials were analyzed. Many analyses of spray deposits were made in evaluating different spray mixtures for codling moth control. More than 300 samples of nursery soils treated with lead arsenate to control the Japanese beetle were analyzed. Particle size and other physical properties of a number of insecticides were determined.

Chemical investigations on accessory materials for use with insecticides: Improvements were made in nicotine bentonite spray formulas by the use of soybean oil-Mississippi bentonite, resulting in more uniform spray deposit, easier removal of harvest residue by brushing, and better color development by fruit. Apparatus for more accurate measurement of surface tensions was developed for use in the study of wetting and spreading agents for use with insecticides.

An extensive investigation has been initiated on diluents for the preparation of insecticides. Materials proposed for such use will be examined as to compatibility with insecticides, particle size, adhesiveness, and other pertinent physical and chemical properties. Information in this somewhat neglected field is much needed for a rational approach to the formulation of effective and economical insecticides.

Chemical investigation of attractants and repellents: Considerable further progress was made in identifying the sex-attractant of the female gypsy moth. Trap material for the gypsy moth was prepared for use in control work.

Methods for evaluating variations in composition and volatility of Japanese beetle attractant mixtures during evaporation were developed. Hollow, cylindrical, filter paper wicks tested in Japanese beetle traps were found to give evaporation rates similar to the standard torch wicks and are cheap, easy to prepare, and permit easy salvaging of excess bait.

Many compounds were prepared for testing as mosquito repellents, several of which showed promise. A number of materials were also furnished for testing as attractants for codling moth larvae.

Chemical investigations on fumigants: Work with liquefied gas aerosols was very active. Investigation of diluents and substitutes for Freon-12 as a propellant gas indicated that methyl chloride possesses suitable properties. Improved formulas for DDT-pyrethrum aerosols were developed. A study was made of the effect of various cosolvents, pyrethrum extracts, etc., on the stability of aerosol mixtures and the corrosion of the containers. The particle size distribution in aerosols and its correlation with insecticidal effect was investigated. A formula for a DDT aerosol for use on certain truck crop insects was developed. The aerosol method was found suitable for the application of plant hormones. Various types of aerosol containers and valves were tested and aerosol formulas investigated.

Further data were obtained on the relative performance of gastight and duck tents in hydrocyanic acid fumigation of citrus for the control of California red scale. The new dosage schedule worked out for gastight tents made possible the duplication of concentrations from tree to tree and night to night which was not possible previously. The blower applicator developed by this Bureau for hydrocyanic acid was shown to give somewhat better kills of the scale than the commercial vaporizer.

Improved emulsible mixtures were developed for soil fumigation to control the Japanese beetle.

Chemical investigations on insecticidal plants and their constituents: The structure of the pyrethrins, the active constituents of the insecticidal plant pyrethrum, has been intensively investigated. Certain components which have been named "cinerins", not previously known to be present, have been isolated and are undergoing chemical and physiological study. There have been further developments in the preparation and stabilization of highly purified pyrethrin concentrates and methods of analysis for such materials. These concentrates have been shown to be free from the irritating properties of ordinary pyrethrum preparations and suitable for use in aerosols.

The active insecticidal principle of Erigeron affinis, a plant of outstanding toxicity to houseflies and some other insects, was isolated and its chemical structure determined.

The alkaloid anabasine was extracted from the domestic plant Nicotiana glauca in quantities sufficient for field tests against certain insects. The alkaloid nornicotine was shown to occur in a number of species of tobacco and in various commercial nicotine preparations. A comparison of the insecticidal potency of the three related alkaloids nicotine, nornicotine, and anabasine is in progress.

Numerous plant samples from various sources were prepared for insecticidal tests.

Chemical investigations on removal of spray residues: Experimental washing treatments were conducted in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering for the purpose of developing suitable methods of removing DDT spray residues from apples. This work will be continued.

Chemical investigations to develop synthetic organic insecticides: Intensive chemical and physical investigations of DDT and the development of effective formulations for its use have continued. Extensive work has been carried on in developing the use of DDT for the control of insects which harass the armed forces and in addition much has been done on the problems involved in the use of this insecticide for the control of agricultural and household pests. The compatibility of DDT with many materials including common insecticides, fungicides, fertilizers and diluents has been studied. Analytical methods have been developed suitable for the determination of DDT in insecticides, spray residues, water, insect tissues, etc. Manufacturers of DDT have been advised on problems encountered, and specifications have been developed for the commercial grades of DDT. A double spray apparatus which promises to be useful in the application of DDT sprays was devised.

About 150 organic compounds of various classes were prepared for testing as insecticides, lousicides, mosquito larvicides, insect repellents, and synergists. A number of these show promising toxic properties toward insects.

(Continued on next page)

(c) Insect and Plant Disease Control

Appropriation Act, 1946		$2,298,300
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+ 317,000
Total anticipated available, 1946		2,615,300
Budget estimate, 1947		2,945,000
Change for 1947:		
Overtime decrease	- 53,300	
Increase	+383,000	+ 329,700

PROJECT STATEMENT

[Note--Amounts in parenthesis opposite the alphabetically designated subprojects represent the details of the numerically identified main projects which immediately precede]

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Japanese beetle control	337,118	386,800	390,000	+ 3,200(1)
(a) Supervision of nurseries and greenhouses	(177,600)	(196,900)	(198,500)	(+ 1,600)
(b) Scouting adjacent to nurseries and greenhouses	(27,300)	(29,400)	(29,600)	(+ 200)
(c) Trapping to determine distribution	(52,351)	(69,600)	(70,200)	(+ 600)
(d) Soil treatment and trapping in isolated areas to aid in preventing spread	(31,300)	(34,100)	(34,400)	(+ 300)
(e) Farm products inspection	(30,700)	(34,000)	(34,300)	(+ 300)
(f) Vehicular inspection	(17,867)	(22,800)	(23,000)	(+ 200)
2. Sweet potato weevil control	68,804	77,900	100,000	+ 22,100(2)
3. Mexican fruitfly control	149,668	167,100	168,400	+ 1,300(3)
4. Inspection and certification for gypsy and brown-tail moth control	104,379	136,000	136,500	+ 500(3)
5. Control operations for gypsy and brown-tail moths	254,614	306,300	404,800	+ 98,500(4)
(a) Work in barrier zone	(148,700)	(169,300)	(171,000)	(+ 1,700)
(b) Work outside of barrier zone	(105,914)	(137,000)	(233,800)	(+96,800)

PROJECT STATEMENT - Continued

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
6. Dutch elm disease control	251,238	284,200	285,500	+ 1,300(5)
(a) Identification of disease in trees suspected to be infected with Dutch elm disease	(23,100)	(24,400)	(24,500)	(+ 100)
(b) Quarantine enforcement	(48,500)	(54,900)	(55,200)	(+ 300)
(c) Surveys to determine where the Dutch elm disease occurs as a basis for quarantine enforcement	(137,438)	(158,300)	(159,000)	(+ 700)
(d) Experimental control work to determine what action may be taken by cooperating agencies to protect valuable elms in areas of general infection.	(42,200)	(46,600)	(46,800)	(+ 200)
7. Phony peach and peach mosaic eradication	89,364	128,500	128,700	+ 200(5)
8. Barberry eradication	249,926	282,800	284,200	+ 1,400(5)
(a) Eradication of the barberry	(245,026)	(277,100)	(278,500)	(+ 1,400)
(b) Inspection of nurseries which ship barberries interstate	(4,900)	(5,700)	(5,700)	- -
9. Pink bollworm and thurberia weevil control	698,052	740,200	994,500	+254,300(6)
(a) Suppression and prevention of spread of the pink bollworm.	(487,552)	(511,400)	(698,800)	(+187,400)
(b) Eradication of wild cotton in Florida for protection of cultivated cotton from pink bollworm	(115,500)	(122,900)	(160,800)	(+37,900)
(c) Cooperation with the Mexican Government to control pink bollworm infestations to prevent spread into the United States	(95,000)	(105,900)	(134,900)	(+29,000)
10. Transit inspection	45,323	52,200	52,400	+ 200(7)
11. Overtime pay	332,386	53,300	- -	- 53,300

PROJECT STATEMENT - Continued

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
Covered into Treasury as miscellaneous receipts, Public Law 529	977	- -	- -	- -
Unobligated balance	22,121	- -	- -	- -
Total available	2,603,970	2,615,300	2,945,000	+329,700
Transferred to "Salaries and expenses, Office of Information, Department of Agriculture"	+1,560	- -	- -	
Transferred from "Salaries and expenses, Foreign Plant Quarantines"	-34,000	- -	- -	
Anticipated supplemental	- -	- 317,000	- -	
Total estimate or appropriation (1945 adjusted for comparability)	2,571,530	2,298,300	2,945,000	

INCREASES OR DECREASES

The net increase of $329,700 in this item for 1947 consists of the $53,300 decrease for overtime and the following:

(1) An increase of $3,200 under the project "Japanese beetle control" for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(2) An increase of $22,100 under the project "Sweetpotato weevil control" composed of:

(a) An increase of $21,500 to make surveys in the Gulf Coast and contiguous states which produce seed sweetpotatoes for distribution in extensive commercial producing southern states and to increase cooperation with the State of Louisiana, local agencies, and growers in applying suppressive measures in the generally infested extensive commercial sweetpotato producing area in central Louisiana.

Objective: (1) To make a limited survey of seed sweetpotato producing areas in Alabama, west Florida, Georgia, Louisiana, Mississippi, and Texas for the purpose of locating and promptly eradicating incipient infestations which might become centers of weevil spread through the medium of seed sweetpotatoes; and (2) to augment and extend suppressive work recently inaugurated in cooperation with the state officials,

local agencies, and growers in a generally and heavily infested commercial sweetpotato producing area in central Louisiana which produces a major portion of southern grown sweetpotatoes shipped interstate and is a constant threat in the spread of infestation to all other southern producing areas. This extension of the work is important to the success of the work program in other areas and is necessary because of the expanded utilization of sweetpotatoes as an out-growth of the war effort and the post-war uses of this crop in the southern states.

The Problem and its Significance: The cooperative, suppressive, and eradication work heretofore included in the program has been restricted to those areas where wild hosts do not persist throughout the year or where the infestations are incipient in character or have not developed to the point of being heavy and general throughout commercial sweetpotato producing sections. The extensive, commercial sweetpotato producing area in south-central Louisiana has been heavily and generally infested for years and has been excluded from the Federal cooperative program even though its economic losses from sweetpotato weevils have occurred annually. Prior to the war period and the expanded utilization of sweetpotatoes, these heavy infestations and losses were primarily a local problem which did not appreciably jeopardize the remainder of the sweetpotato producing areas in the south. Potato planting stock was not certified for movement from this area and the principal markets for the table stock grown therein were in the northern states where sweetpotatoes are not generally grown and the sweetpotato weevil was no problem. During the war extensive markets and numerous processing plants were developed and located in the South and there was a vast increase in the demand for potato planting stock. Large quantities of infested potatoes, both for table use and planting purposes, have been shipped from this generally infested area in central Louisiana throughout the South. This movement, which is continuing, has and is exposing to weevil infestation not only the areas where eradication has been accomplished but other southern producing areas not heretofore infested. The locating of infestations that may have been established is highly important. To prevent movement from this area of high commercial production is not practicable or economically feasible, especially during the period of high demand for sweetpotatoes for food and starch. To protect other areas and the work which has been done, it is highly important that the infestation be reduced at the source. The nature of the problem and the means that should be used as well as the amount of work required needs concerted effort and Federal aid. All the cooperating states recognize this and because of its importance to their work favor the proposed recasting of the program. Curtailment or material adjustment of work now being done under the established program would mean surrendering what has been gained in work areas, and additional funds are required to meet these new developments.

New uses for the sweetpotato have been developed; methods of processing for both food and feed are in general commercial practice; and a large number of processing plants have been and are being constructed through the South and represent extensive investments which afford profitable and adequate markets for this crop as well as employment for

local people. The sweetpotato as an important money crop in the South, therefore, is in a favorable position and continued expansion in this industry is anticipated. The sweetpotato weevil is the most destructive insect pest of sweetpotatoes and a limiting factor in the production and utilization of the crop. Prompt and effective action on the part of the Federal Government, the states, and local communities should be taken to locate and eradicate new infestations that may be established and reduce or eliminate spread from generally infested areas, such as the section of south-central Louisiana which now is jeopardizing the sweetpotato industry of the entire South, in order to maintain the favorable position of the crop and to permit continued expansion of production and utilization.

Plan of Work: The limited survey would be conducted cooperatively with the states concerned, and would require additional supervisors, inspectors, transportation, and other costs.

The work in the application of suppressive measures would be conducted on a fully cooperative basis with commensurate and adequate state and grower participation. Such suppressive activities would include (1) post-harvest inspection of sweetpotato fields and supervision of clean-up of infested remnants, (2) spring inspection of storages and disposal of storage residues, (3) selection with growers of planting sites adequately distant from infested fields to prevent infestation, (4) fumigation, at growers or shippers expense, of infested market and planting stock, cuttings, slips, and draws, and (5) educational effort through county agents and inspectors on means of producing weevil-free potatoes.

(b) An increase of $600 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(3) Increases totaling $1,800 under Projects 3 and 4, as shown on the project statement, for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(4) An increase of $98,500 under the project "Control operations for gypsy and brown-tail moths" composed of:

(a) An increase of $95,600 for intensifying gypsy moth control in Pennsylvania and other strategic areas west of the Hudson River and in preventing further spread to uninfested areas.

The Problem and its Significance: The gypsy moth is generally distributed in wooded areas in Massachusetts and parts of adjoining States. It is known to occur as a more or less spotted infestation over about 2,000 square miles west of the Hudson River in New York State involving Saratoga, Schenectady, Albany and parts of Fulton, Montgomery, Greene, and Warren Counties. An isolated infestation centering at Wilkes-Barre, Pennsylvania involves an estimated 100,000 acres of infested timber land distributed over about 600 square miles. These areas in New York and Pennsylvania are west of the long-established Barrier Zone, and thus constitute a serious threat of further spread. The volume of

potentially hazardous material moving from infested to non-infested areas has been much greater in recent years due to the war demands for wood, wood products, scrap metal, etc. The dangerous potentialities of the gypsy moth are shown by the fact that in 1945 woodlands totaling in excess of 800,000 acres, mostly in Massachusetts, but to some extent in adjacent States were defoliated to the extent of 25% to 100%. The effectiveness of the Barrier Zone as a protective area for the States to the west of it will be seriously impaired unless these scattered outbreaks are promptly and vigorously attacked.

Plan of Work: The recommended increase of $95,600 will be used (1) to intensify surveys to the extent necessary to accurately define, map, and flag areas to be treated, and to check the effectiveness of control, and (2) to treat an estimated 9,000 acres of infestation in Pennsylvania, 7,000 in New York, and 1,000 in the Barrier Zone. In applying this treatment full utilization will be made of newly-developed insecticides highly toxic to gypsy moth and recently perfected devices for applying them. Use would be made of both aircraft and ground spray equipment. To carry out this program it would be necessary to (1) acquire and equip two additional airplanes (a total of four)for gypsy moth control and to provide for their maintenance, storage, and operation; (2) expand surveys to meet the needs of the proposed control program; (3) provide for the personnel necessary to operate and service the aircraft and ground equipment that would be used, and (4) purchase automotive and other equipment, including insecticides, that would be needed.

(b) An increase of $2,900 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(5) Increases totaling $2,900 under Projects 6, 7 and 8, as shown on the Project Statement, for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(6) An increase of $254,300 under the project "Pink bollworm and Thurberia weevil control" composed of:

(a) An increase of $185,000 to expand the inspection, control, and regulatory work for suppression and prevention of spread of the pink bollworm.

Objective: To conduct intensive field inspection to locate heavy pink bollworm infestation in the Lower Rio Grande Valley of Texas and Mexico, to provide control materials for application where needed and actually to apply such measures in locations where the need is indicated; to provide adequate supervision for the 296 processing plants in 28 new counties placed under quarantine in Southern and Western Texas because of spread of the pink bollworm during the 1943-1944 cotton crop seasons; and to expand and intensify inspection for pink bollworm made necessary by the greatly increased perimeter of the pink bollworm quarantine line.

The Problem and its Significance: The build-up of pink bollworm infestation in the Lower Rio Grande Valley of Texas and in contiguous territory in Mexico in 1943 and 1944 resulted in the spread of this insect in those years to 28 new Texas counties. The situation became so grave as to lead to serious consideration of the establishment of non-cotton zones to guard against continued spread of infestation to additional cotton-producing areas in the United States. However during the 1945 field season intensive control and cleanup efforts and favorable weather conditions combined to bring about an improvement in the situation. To avoid the imposition of non-cotton zones and recognizing the threat to continued successful production of cotton within the area, growers organized so as to render more effective cooperation to the State and Federal program, the fall cleanup date being advanced to September 1 as compared with an average date of October 15 in past seasons. It is imperative, however, that this aggressive effort which reduces the number of hibernating worms be continued and that steps be taken to bring about a further substantial reduction in the pink bollworm populations in this area, since past experience indicates that they have not been reduced so greatly as to eliminate hazards of spread. A new and favorable factor is the development of DDT, which for the first time makes available a control method effective against the pink bollworm during the growing period when moth flight occurs. The results of large-scale experimental control during the 1945 field season indicate that the application of DDT to local areas showing high infestation beginning as early as these appear rather than waiting until after harvest for control as is now required, offers great promise of substantially reduced infestation. Such reductions in populations will of course reduce the danger of spread of this destructive insect to additional cotton-producing areas in the South. The addition of 18 South Texas counties to the quarantined area increased cotton acreage under quarantine in South Texas from approximately 475,000 acres to approximately 750,000 acres. This increase of 275,000 acres adds to the problems involved in creating a host-free period in the late summer and early fall to stop breeding of the pink bollworm. The spread into 18 additional South Texas counties and 10 West Texas counties has increased materially the length of the quarantine line. This spread has also resulted in bringing the infestation close to the main cotton producing areas in Texas which are highly susceptible to infestation by the pink bollworm and has proportionately increased the area in which intensive inspection must be conducted at the gins and in the cotton fields to detect as quickly as possible any new infestation which might develop in such areas. The spread of infestation in the 1943-1944 crop seasons resulted in placing 28 additional Texas counties under pink bollworm quarantine. This increased the number of gins in the regulated area from 347 to 624, an increase of 277; oil mills from 21 to 33, an increase of 12; compresses from 9 to 16, an increase of 7. In addition, a number of plants located outside the area are designated to receive, treat and process cotton and its products and must be supervised.

Plan of Work: It is proposed to conduct an intensive field-to-field inspection in the area on both sides of the Mexican Border in which heavy infestation is known to exist. This work would be conducted during the

period April to June, in the early period of the fruiting of the cotton. Present indications are that inspections of this type should be conducted on approximately 90,000 acres in the Lower Rio Grande Valley of Texas and 75,000 acres in adjacent area of Mexico. Applications of DDT would be made when and where they are needed, as determined by intensive inspections to locate hazardous populations which may result in spread of moths by flight. Applications will probably be made through combined use of ground and air equipment involving some use of rented aircraft on a contract basis with crop dusting concerns. It will also be necessary to expand the control program to provide for destruction of cotton plants in the newly-infested counties as well as the old area, promptly following harvest in order to create a host-free period during a part of the year. This will require additional personnel and equipment in order to contact the cotton growers of the area to secure compliance with the regulation requiring the prompt destruction of cotton plants in additional counties involving approximately 275,000 acres of cotton in 18 South Texas counties. It will be necessary to conduct intensive gin trash and field inspections in a greatly increased number of counties now immediately adjacent to known infested counties. Previously such counties were sufficiently removed from the area that general inspections only were adequate. The primary plan would involve use of additional gin trash inspection machines but this would be supplemented with field-to-field inspection in certain areas. It is estimated an additional 10,000 inspections would be required to supervise the processing plants in counties recently added to the quarantine area.

(b) An increase of $37,300 for eradication of wild cotton which serves as a host plant for pink bollworm.

Objective: To conduct an intensive program of scouting in area adjacent to known wild cotton locations in which only general surveys have been carried on during the past several years; to reclean for a third time during a single season all of the areas in which wild cotton growth is especially prolific such as the Cape Sable area, the Florida Bay Keys and the Mainland Keys between Homestead and Key West, Florida.

The Problem and its Significance: The wild cotton grows continuously throughout the year and it is necessary to conduct intensive surveys of areas closely adjacent to those where wild cotton is known to be present. This is particularly essential in South Florida where the tropical hurricanes occur periodically and which in the past have been known to spread mature wild cotton bolls and open locks of seed cotton, thereby starting a growth of these plants in areas formerly free of them. So long as wild cotton bolls are permitted to mature and open there is a strong likelihood of dispersal of seed to new areas. There are hundreds of miles of shoreline on the mainland of Florida and on the Keys or islands in the Bays on which wild cotton thrives. It is necessary because of the tropical vegetation to cover on foot with trained scouts and workers the area in a very intensive manner. Progress of scouting is extremely slow due to the necessity of cutting through heavy undergrowth to reach the natural clearings where the wild cotton plants flourish. While good progress has been made on this project, its expedition is necessary to minimize a severe potential danger to important cotton-growing areas.

Plan of Work: It is proposed to conduct an intensive survey of all areas adjacent to known locations of wild cotton. Particular emphasis would be given to a most thorough coverage of the areas which have been visited by tropical hurricanes during the past several years. New trails would have to be cut and undergrowth cleared away in order to reach almost inaccessible areas in which seed may have been carried by wind or high water. In order to prevent fruiting of wild cotton the areas must be covered and recovered during the course of the year. If too long a period elapses between the last cleaning in the late spring and resumption of the work in the fall a crop of wild cotton bolls will be produced, mature and shed seed cotton on the ground, resulting in a new crop of seedling plants. It is planned to cover all of the area three times each year, digging or pulling out the plants before sufficient time has been allowed them to produce bolls. All of this involves the organization of small crews of scouts, larger crews of laborers, and their transportation, and maintenance in areas remote from the populated areas of the State.

(c) An increase of $28,600 for expansion of the program being carried on in cooperation with the Government of Mexico for the control of the pink bollworm in Mexico as a means of minimizing the danger of spread into the United States.

Objective: To prevent spread of the pink bollworm to additional areas of the United States by securing the most effective possible cooperation with the Mexican Department of Agriculture and local agencies in carrying on more extensive and comprehensive programs in connection with suppression of the pink bollworm in Mexican areas.

The Problem and its Significance: It has been reliably estimated that above 90% of the pink bollworm population in the cotton on the North American Continent is to be found in the Laguna and Delicias cotton growing regions of Mexico. The creation of a host-free period in the Border area of the United States would largely be nullified if the Mexican authorities permitted their growers to allow cotton to continue growing and breeding pink bollworms. It therefore is vital to the United States that Mexico adopt more stringent pink bollworm suppressive measures. Since the effort to secure greater cooperation between the two governments began, there has been progress in the control programs in effect in the two countries. As this develops, the value of the work conducted solely on the American side of the Border is expected to increase. In general the problems of controlling the pink bollworm in the two countries closely parallel each other, with the very distinct difference that practically all of the important cotton growing areas of Mexico are already infested whereas only about 5% of the United States cotton area is infested.

Plan of Work: The plan now being followed in Mexico involves the use of trained technical employees of the Bureau, not only in the areas immediately adjacent to the Border but in the great cotton-producing regions of the interior of Mexico. Bureau employees work directly with appropriate national and local Mexican officials in all phases of pink bollworm control including educational work with growers and processors.

It is planned to expand this type of assistance so as to cover new cotton-producing areas near the Border and to intensify the work in areas previously covered.

(d) An increase of $3,400 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(7) An increase of $200 under the project "Transit inspection" for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

WORK UNDER THIS APPROPRIATION

Objective: In cooperation with States, to protect American agriculture from destructive insect pests and plant diseases by the application of control measures directed at eradication, suppression or prevention of spread, depending upon the degree of risk involved, the source and extent of the infestations, and the effectiveness of available control measures.

The Problem and its Significance: Control programs currently receiving attention include insect pests or plant diseases falling into two general categories (1) those involving the eradication, suppression or prevention of spread of introduced pests that have become established in limited areas and threaten to spread to other parts of the country and (2) those of more general distribution which can be more effectively and economically controlled by federal, state and community action than by individual farmers. The principal pests dealt with under this appropriation are the Japanese beetle, the sweet potato weevil, the Mexican fruitfly, the Gypsy and brown-tail moths, the pink bollworm and Thurberia weevil, all of which are serious insect pests, and the injurious plant diseases known as Dutch elm disease, phony peach, peach mosaic, and black stem rust of wheat. All of these pests, if uncontrolled, are capable of taking an exceedingly heavy toll in annual damage to agricultural products and forests and affect crops of great importance. Control of these pests not only reduces or eliminates the losses caused by them currently, but prevents future damage over much larger areas. The problem is peculiarly difficult in that while safeguards must be provided against the spread of these various pests, they must still permit, to the greatest extent possible, the movement of agricultural products which are badly needed in areas where they are not grown and on which thousands of producers depend for a livelihood.

General Plan: Immediate responsibility for the Bureau's program of work under this appropriation lies with subject-matter control divisions which are strategically located so as to deal most effectively with the various pests. These divisions are Japanese Beetle Control, which conducts operations also against Dutch elm disease; Domestic Plant Quarantines, which conducts activities against sweet potato weevils, phony peach, and peach mosaic, and the transit inspection work carried on at principal distribution centers throughout the country; Gypsy Moth Control; Mexican Fruitfly Control; Plant Disease Control, which directs barberry eradication work to prevent black stem rust of wheat; and Pink Bollworm Control. In all of these control programs substantial cooperation is supplied by affected states and in some instances by counties, municipalities and other public agencies. The Republic of Mexico cooperates in the control efforts directed against the pink bollworm and the Mexican fruitfly. The actual work programs in these various fields necessarily differ quite widely.

Progress and Current Program by Financial Projects.

1. Japanese Beetle Control

General Statement: The area regulated by the Japanese beetle quarantine includes parts of Maine, New Hampshire, Vermont, New York, Pennsylvania, Ohio, Maryland, West Virginia, Virginia, and all of Massachusetts, Rhode Island, Connecticut, New Jersey, Delaware, and the District of Columbia. There must be supervision and inspection to insure the proper treatment and handling of the products restricted by the quarantine with a minimum of inconvenience to the public. There must be a regular survey of premises to determine the status of infestation so that adequate measures, either piece-by-piece inspection, fumigation, or general permit certification, may be adopted in each case. In addition, points in non-regulated territory considered as likely to be infested by the insect are surveyed through the use of traps, and isolated infestations discovered are dealt with either through quarantine or through arrangements with those interested in cooperative control. Arrangements are made for airplane, truck, railroad and mail inspection or treatment of materials as required. Efforts also are made in cooperation with research units of the Bureau to develop new, safe, and inexpensive treatments of plants and plant products to permit them to meet the requirements of inspection and certification. Practically every state in the regulated area furnishes active cooperation.

Farm Products Inspection: During the fiscal year 1945 there was a slight increase in the size of the generally infested section of the regulated area, the principal addition being Nassau County and parts of Suffolk County, Long Island, New York.

During the fiscal year approximately 3,972 carloads and truck loads of restricted fruits and vegetables were certified for shipment. This was less than the 5,753 carloads and truck loads in the fiscal year 1944, the decrease in shipments probably being due to the severe drought in the summer of 1944. A total of 3,857 refrigerator carloads and 115 truck loads of fruits and vegetables were fumigated with Methyl bromide, and 2,017 empty refrigerator cars and motor trucks were inspected or fumigated prior to loading with certified fruits and vegetables.

As a result of experimental work carried on in cooperation with a research unit of the Bureau during the fiscal year 1945, Methyl bromide treatments of refrigerator cars and trucks were modified and made more effective. It is hoped that experimental work with DDT by a cooperating research unit of the Bureau will lead to methods of treatment that will also safeguard products for interstate transportation and further expedite their handling.

Scouting Adjacent to Nurseries and Greenhouses: During the fiscal year 1945, 1,056 noninfested nurseries and greenhouse units concerned with the movement of plants with soil about their roots were scouted. These establishments were scattered widely throughout the area regulated under the Japanese beetle quarantine and the properties and ground adjacent

te them were scouted from two to four times during the flight period of the adult Japanese beetle. Infestation was found on 71 of these establishments, and in the vicinity of 25 others.

Soil Treatment and Trapping in Isolated Areas to Aid in Preventing Spread of Japanese Beetles: During the fiscal year 1945 lead arsenate soil treatment was applied to 921 acres in outlying infestations at 43 localities in 9 states. This brings the total of such treated areas to more than 7,800 acres. In the fiscal year 1944 treatments were applied to 890 acres at 53 localities in 10 States to control incipient or recently discovered infestations.

The Division of Japanese Beetle Control and the Division of Fruit Insects are cooperating in a large scale field experiment to suppress the beetle at an established isolated infestation at Blowing Rock, North Carolina. An insecticidal dust containing DDT has been applied as a surface soil treatment to approximately 225 acres. 10,000 to 12,000 gallons of DDT spray mixture is being applied to tree and shrub foliage there.

There follows a summary of the lead arsenate and DDT soil treatments applied during the fiscal year 1945:

STATE	ACRES
Florida	8
Georgia	3
Illinois	162
Indiana	189
Michigan	89
Missouri	3
New York	66
No. Carolina	
Lead	108
DDT	225
Ohio	291
Tennessee	2

TOTAL STATES	10
TOTAL ACRES	
Arsenate Lead	921
DDT	225

Supervision of Nurseries and Greenhouses: During the fiscal year 1945 the area under regulation was extended slightly, adding 88 square miles for a present total of 127,858 square miles. Forty-one additional plant growing and shipping properties were found to be infested sufficiently to require that plant material and soil be inspected on a piece basis or fumigated in order to obtain quarantine certification.

During the 1945 fiscal year 63,948,130 units of plant material and 1,280 tons of soil and manure were certified for shipment. Certification was necessary at 1,098 commercial establishments, and for an additional number of individuals.

The Division of Japanese Beetle Control and the Bureau Research Divisions working on Japanese beetle problems are continuing efforts to produce treatments more practicable, efficient and safe for the use of plant shippers. As a result of tests during the past year a more satisfactory ethylene dichloride mixture for use in plant dip treatments was authorized. Promising results have been obtained in tests with a new mixture of ethylene dichloride and ethylene dibromide. DDT is being used in other tests and it is hoped that by the time it becomes available for commercial use its use as an alternative or improved method of treatment may be warranted.

Trapping to Determine Distribution of Japanese Beetles: During the calendar year of 1945 more than 58,000 traps are being operated in 665 localities in 34 states as indicated in the table below. This compares with 68,700 during the 1944 calendar year, when traps were placed in 428 different localities, with positive results at 112. This is scouting of territory outside of that known to be infested in order to obtain information about the distribution and dissemination of the insect. Inexpensive metal traps containing an aromatic liquid which attracts the Japanese beetle are used for this purpose. This trapping work, designed particularly to determine new localities where the Japanese beetle occurs or is becoming established, has been necessarily curtailed somewhat in recent years. The current program includes surveys at major airports in noninfested areas. In the interest of control and retardation of further spread, a prompt determination of the presence of the Japanese beetle in a locality is highly important.

State	No. Traps	State	No. Traps
Alabama	48	Montana	48
Arizona	48	Nevada	24
Arkansas	24	New York	2840
California	1300	No. Carolina	4650
Colorado	150	No. Dakota	24
Florida	1020	Ohio	5850
Georgia	2048	Oklahoma	48
Idaho	24	Oregon	24
Illinois	11000	So. Carolina	2199
Indiana	4350	Tennessee	3300
Kansas	400	Texas	144
Kentucky	3625	Utah	24
Louisiana	24	Vermont	500
Michigan	7400	Virginia	1625
Minnesota	24	Washington	24
Mississippi	24	W. Virginia	965
Missouri	4540	Wyoming	24
		Total Traps	58,362

Vehicular Inspection: During the fiscal year 1945 the highway inspection section of this activity was confined exclusively to the checking of motor trucks leaving the heavily infested section of the regulated area. Eight stations were in operation. A total of approximately 72,000 trucks was inspected and 473 of these were found to be transporting uncertified produce. A large number of Japanese beetles were removed from the trucks and destroyed.

Efforts have been made to prevent dissemination of the adult beetle in commercial and military airplanes. The Secretary of Navy and the Secretary of War have cooperated by issuing orders to all personnel concerned to assist in this matter; commercial airline officials also are cooperating. Representatives of this project have visited all important military and commercial airfields in the heavily infested sections of the Japanese beetle regulated area. The Division of Japanese Beetle Control is cooperating with a Bureau Research Division in tests with aerosols and sprays designed to kill beetles in airplanes.

In the airplane inspection work contacts are being expanded because of increased interest on the part of the military, increased military air movement and the prospect for greatly increased commercial air movement in the near future. Aerosol or spray treatment of airplanes may be instituted on an experimental basis this summer in cooperation with Military officials, and demonstration treatments may be made in commercial planes.

2. Sweetpotato Weevil Control.

General Statement: Activities are designed to accomplish eradication of the weevil in commercial producing areas and to effect its drastic suppression in noncommercial areas to prevent build-up and possible spread to other areas. The work program includes (a) inspections to locate infestations and determine their extent and intensity; (b) operations to eradicate the pest from or to control it in infested plantings by means of the destruction of potatoes in infested seed beds and storage banks, the clenn-up of fields after harvest and the eradication of wild host plants; (c) cooperation with States in the enforcement of regulatory measures. Cooperating states throughout the control area are contributing to this program during the fiscal year 1946.

Control Program: The eradication activities directed against the sweetpotato weevil conducted cooperatively with the growers, counties, and States were continued during the calendar year 1944 in the States of Alabama, Georgia, Louisiana, Mississippi, and Texas, and extended to northwestern Florida, where infestations in the commercial sweetpotato producing area were discovered. Over 35,000 inspections were made during the 1944 calendar year in 70 counties of the above states. Forty-one of these counties were found to be apparently free of infestation.

A total of 2,431 farms in 29 counties was in the process of eradication at the beginning of the year. Intensive eradication efforts on these farms were continued during the year which resulted in releasing 2,106 from planting restrictions for the reason that no specimens of the weevil

were found on the premises for a period of at least 12 months ending during the year. This completed eradication of all known infestations in 6 additional counties in Alabama, Louisiana, Mississippi, and Texas. However, during the year 631 additional infestations were found, including a number of reinfestations in areas in which eradication apparently had been completed as well as infestations in commercial potato producing areas in 6 counties of 3 states in which repeated annual inspections had revealed no prior infestation. In addition to these newly established infestations, many lots of infested potatoes moving to various points in the South for both table stock and seed purposes have been intercepted through the efforts of state and Federal inspectors.

Despite the very effective progress made during past years in the eradication of the weevil in the infested commercial potato producing areas, the high number of new infestations found during the year in widely scattered commercial potato counties which have not been previously infested, and the extensive movement of infested sweetpotatoes and plants for planting purposes, constitute an increasing problem of both inspection and eradication.

The abnormal recent spread of the weevil seems to be directly attributable to the heavy demand for increased sweetpotato production which has exceeded the supply of weevil-free, certified planting stock. Most of the established new infestations as well as the infested potatoes moving to points within the South originate in a few extensive sweetpotato producing areas where weevil infestations have been generally established for a long number of years. Prior to the war, potatoes from these areas were shipped almost exclusively to northern markets, in which areas no certified planting stock was grown. Therefore, no Federal eradication attempts have been previously undertaken therein. The shortage of planting stock plus the recent heavy demand for table stock at military establishments and in the vicinity of shipbuilding and other war industrial plants in the South have resulted in the extensive marketing of infested potatoes from these areas. The State of Louisiana in which most of these infested potatoes are grown has very materially increased, though not adequately, the State efforts to suppress weevil populations in these heavily infested areas. Therefore, the likelihood of further spread of weevils to noninfested potato producing sections of the South still exists.

3. Mexican Fruit Fly Control.

General Statement: The general work plan is (a) by periodic grove and field inspections through examination of fruit and operation of traps, to determine the presence or absence of the Mexican fruit fly; (b) by inspection of citrus packing and processing plants to insure that fruit being packed, processed, or shipped will be moved in accordance with quarantine regulations; (c) to maintain a complete host-free period, insofar as such susceptible hosts as grapefruit, sour oranges, peaches, etc., are concerned during the period from June 15 to September 1, in order to prevent oviposition and resultant increase in the

fly population through the summer months; (d) to route fruit from infested groves through sterilization rooms so that any living larvae in the fruit will be destroyed; (e) to inspect markets and fruit trees in Mexico adjacent to the regulated area in Texas with the object of holding down infestations which could easily spread to Texas groves; (f) to control the movement of citrus fruit by motor vehicles through operation of road traffic inspection stations at strategic points. The work is organized under three projects: (a) Grove and packing house inspection and certification; (b) spraying and control in Mexico; and (c) vehicular inspection. The State of Texas and the Republic of Mexico are cooperating in this work.

Control Program: Sterilization of citrus fruit has been generally adopted throughout the area regulated under Quarantine No. 64 and as this method prevents the spread of the Mexican Fruit Fly to uninfested areas, the fruit harvesting season was extended last year from April 30 to June 15 for grapefruit and throughout the year for oranges. During the 1945 shipping season, on account of increased findings of larval infested fruit, all grapefruit was required to be sterilized before shipment on and after April 23.

On the basis of substantially complete figures, rail shipments of fruit for the year increased approximately 30 per cent from 29,387 to 39,487 cars, while truck shipments remained practically at the same figure as last year, 5,472 for 1943-44, 5,461 for 1944-45. Express shipments increased approximately 35 per cent over the previous years and fruit processed is estimated at 2,000 equivalent carlots. Production of citrus fruit showed an increase for the year of approximately 12 per cent from 59,166 carlots in 1943-44, 66,515 carlots in 1944-45. The harvesting, inspection, certification, and movement of this fruit is shown in the following table for the past season as well as for the three other preceding seasons.

	Equivalent Carlots			
	1941-42	1942-43	1943-44	1944-45
Rail	18,566.2	27,995.0	29,387.1	39,487.7
Truck	9,694.9	5,061.0	5,472.1	5,461.6
Express & Passenger Cars	820.0	920.0	1,160.0	1,566.0
Processed	16,606.3	20,388.0	23,147.0	20,000.0
Total carlots	45,687.4	54,364.0	59,166.2	66,515.3

Two road stations were again operated in cooperation with the Border Patrol of the Department of Justice and the Pink Bollworm Division of the Bureau of Entomology and Plant Quarantine. The location of these stations make them excellent sites for inspection of not only fruit and cotton but for the work of the Border Patrol.

4. Inspection and Certification for Gypsy and Brown-tail Moth Control.

General Statement: Inspection and certification service is maintained from strategic points throughout the State of Rhode Island and parts of Maine, New Hampshire, New York, Vermont, Massachusetts, and Connecticut, which comprise the regulated area.

Inspection and Certification: There was a considerable increase in the inspection work load during the 1945 fiscal year as compared with the previous year. Shipments certified are estimated at 155,000, an increase of 65,000 over the previous period. Quantities of articles certified were somewhat under the previous year in several important categories, but the larger number of individual shipments certified increased the demands on the inspector's time. Shipments of nursery stock and lumber were slightly lower in each instance, while inspection of pulpwood and fuelwood, involving a large amount of woodlot surveying or piece-by-piece inspection, was considerably increased over last year. Details are shown in the table at the end of this section. Heavier infestation in many sections of the regulated area was reflected in greater quantities of gypsy moth egg clusters being removed from inspected products. Gypsy moth inspection service continued with inspectors stationed in 17 districts into which the regulated area is divided.

Heavy gypsy moth infestation in the Cape Cod Section of Massachusetts and the mass movement from that area of trailers used to house war workers necessitated unusual vigilance on the part of our inspectors to prevent the movement of infestation from that section. Inspection of 109 trailers involved in a mass movement by the Navy of FPHA housing equipment from Otis Field at Falmouth on the Cape resulted in the destruction of 309 gypsy moth egg clusters that otherwise would have accompanied the trailers when they were transported to Charlestown, Indiana, to be used as living quarters for war workers there.

Several district inspectors as well as three men specially assigned to vehicular inspection were stationed on the exit highways from the regulated area during the pre-Christmas season. Forty-five truckloads of uncertified material were intercepted, some were returned to the regulated area for inspection, while a few truckloads were inspected and certified by the inspector who made the interception.

Under a modification of the gypsy moth regulations effective August 26, 1944, Christmas trees and evergreen boughs originating in any part of the regulated area may be certified when fumigated with methyl bromide. Prior to that time, movement of these products from the heavily infested area was prohibited. One hundred and five carloads of Christmas trees and evergreen boughs were fumigated at the shipper's expense during November and December. Inspectors provided by the States of Maine and Vermont performed the fumigations in these two States, using Federally-loaned mobile fumigation units, operated under the supervision of a Federal inspector. The shippers furnished the methyl bromide and the State made a nominal charge for the State inspector's services. Some large shippers supplied their own equipment and made their own fumigations under the observation of a Federal inspector. Fifteen centrally-located Christmas tree inspection centers were in operation in the lightly infested area from the middle of November to the latter part of December. Commercial shippers were required to bring their trees to one of these centers for inspection. This was the first year such inspection centers have been established.

In cooperation with the New York, New Haven & Hartford Railroad, efforts are being made to set up centralized points at which carloads of products regulated under the Gypsy Moth Quarantine may be fumigated en route to destinations in nonregulated areas. This is similar to working arrangements already in operation with the Pennsylvania Railroad for the fumigation of fruits and vegetables shipped from the heavily infested Japanese beetle area.

Tests are being conducted in cooperation with the Division of Control Investigations to establish definite temperature-dosage schedules for the methyl bromide fumigation of non-plant products, from 0°F. up. Studies are also being made in cooperation with the above Division, on the post-fumigation effects on larvae that may hatch from eggs that survive this type of fumigation.

Products Inspected and Certified Under Quarantine No. 45

During Fiscal Years 1944 and 1945

Type of Product	Fiscal Year 1944	Estimated Fiscal Year 1945
Nursery-grown stock (Plants)	6,362,688	6,026,786
Forest Products		
Lumber (Board feet)	190,358,725	190,745,680
Reels	46,087	55,060
Shavings (Bales)	98,237	85,112
Miscellaneous (Carlots)	236	380
" (Trucks)	4	0
" (Tons)	1,105	860
Barrell Parts, Crates, etc. (Bundles)	66,219	52,711
Miscellaneous Material (Pcs., Bags, Bales, Boxes, Bundles, Crates, Pkg. Cartons, Cases)	138,589	168,650
Lags (Bundles)	1,284	2,924
Logs, Piles, Posts, Poles	318,479	1,286,380
Wood (Cords)	54,995	107,563
Evergreen Products		
Boughs, Twigs, Greens (Bales or Boxes)	26,680	31,980
Christmas Trees	419,133	297,838
Miscellaneous (Bags, Bales, Boxes)	5,517	8,757
Roping (Yards)	6,050	0
Laurel (Bales or Boxes)	12,244	8,177
Stone and Quarry Products		
Crushed Rock (Tons)	772	546
Curbing (Running Feet)	3,600	510
Feldspar (Tons)	2,300	32,246
Granite (Pieces)	2,718	10,120

Type of Product	Fiscal Year 1944	Estimated Fiscal Year 1945
Stone and Quarry Products - Cont'd.		
Granite (Tons)	539	4,836
Monumental Stone (Pieces)	11,789	6,779
Grout (Tons)	82	163
Marble (Pieces)	1,033	2,523
Paving Blocks	25,500	54,000
Miscellaneous (Pcs., Bags, Boxes, Crates)	1,530	763
" (Cars)	7	90
" (Tons)	341	2,090
Total Number of Shipments	90,056	155,479
Infestations Removed from Inspected Projects		
Egg Clusters	349	1,414
Larvae	230	46
Pupae	18	93

5. Control Operations for Gypsy and Brown-tail Moths.

General Statement: In Pennsylvania a State quarantine similar to the Federal gypsy moth quarantine is enforced in the infested area cooperatively by the Federal and State organizations. At the western edge of the generally infested area in New York and New England, there is a relatively wide strip of country which, because of the nature and type of forest growth, climatic conditions, and natural barriers, constitutes an effective barrier to rapid development and spread of infestation. In this barrier zone and in certain areas west of it intensive scouting and control work is carried on in order to locate and suppress incipient infestations thus minimizing the chance of spread to the uninfested areas to the West.

Control Operations: During the fiscal years 1944-45 a new type of apparatus consisting of rotating spinner discs attached to a biplane was designed by project employees and used in application of arsenate of lead, cryolite, and DDT in concentrated spray form. During 1944 the pest was eradicated from a 20-acre woodlot in Pennsylvania by the application with a biplane of DDT at the rate of 5 pounds per acre. Similar results were obtained in a 5-acre tract in Saratoga County, New York. During the fiscal year 1945 applications of DDT have been made on more than 5,000 acres of woodland growth in Pennsylvania and in the New York-New England area by aircraft and by hand-operated spray equipment, as well as by ground machines. The dosages used in aerial treatments have ranged from 1/8 pound of DDT in 1 gallon of solvent to 5 pounds of DDT in 5 gallons of solvent per acre. While final checks cannot be made until leaves have fallen, careful and repeated observations indicate a very drastic reduction in pest population in all treated areas except in those receiving dosages of 1/2 pound of DDT or less per acre. Observations were made during the year in cooperation with states, and other Federal agencies to determine the effect of the use of DDT against species of forest insects

other than gypsy moths and against all forms of wildlife, including fish. Some detrimental effect to birds was noted in the area where 5 pounds of DDT was applied per acre. However, in all other tracts where dosages from 1 to 3 pounds per acre were used no detrimental effect was noted. Based on results of observations to date, there appears to be no reason why DDT cannot be used for combating gypsy moths, provided proper dosages are applied and the work is conducted under capable supervision. The development of new equipment for applying insecticides in form of concentrated sprays, either from aircraft or ground machines, brings into use procedures for combating gypsy moth that are far more effective than any available heretofore.

During the past several years emphasis has been placed on sex attractant and manual types of surveys with the control phase of the work operated only on a basis of a holding program. During the summer seasons of the calendar years 1942-43-44 12,800,000 acres were surveyed by the sex attractant method largely around the periphery of the known points of infestation in Pennsylvania and west of the area of known general distribution of the pest in New York and New England. Of great significance was the finding that infestation had apparently been eradicated in 10 entire townships in Pennsylvania involving more than 400 square miles where many areas of infestation previously existed. The Pennsylvania State Gypsy Moth Quarantine was promptly revised to remove those townships from regulation. However, in New York the surveys indicated presence of generally established infestation of relatively light intensity throughout practically the entire counties of Saratoga, Schenectady, and Albany and parts of the counties of Essex, Hamilton, Fulton, Montgomery, Schoharie, Greene, and Ulster west of the Hudson River. It is now believed that the area of general infestation has been delimited. The object of these surveys, aside from delimiting the extent of infestation, was to locate from the standpoint of planning effective control programs, all infestations of sufficient intensity to represent an appreciable hazard of natural spread. The more hazardous areas in Pennsylvania as well as in the New York, New England section were treated to the extent available funds and manpower would permit by application of insecticides from airplanes and ground spray machines and in some areas of small size by creosoting egg masses and by applying burlap bands. Because of the very marked increase in intensity of infestation during the current year, a more aggressive control and quarantine program to protect uninfested sections is now indicated.

6. Dutch Elm Disease Control.

General Statement: Work on the Dutch elm disease consists of (a) surveys to determine where the Dutch elm disease occurs in order to afford basis for quarantine enforcement; (b) the identification of disease organisms by laboratory culture tests; (c) endeavoring to restrict the transportation of diseased material from infected to uninfected sections of the country, and (d) experimental control work to determine what action may be taken by cooperating agencies to

protect valuable elms in areas of general infection. This work is conducted in cooperation with the States involved and is supported by State funds in varying amounts in States where the disease has been found. Cooperation also is extended by county and municipal Governments and other interested parties.

Control Program: The Dutch elm disease control program for fiscal year 1945 included the activities described under "General Plan." Except in the experimental plots, no Federal funds were expended for the removal and destruction of diseased or bark beetle infested trees and items.

The amounts of control work done by State and local effort varied widely in different sections. Because most of the Federal survey work was located at and beyond the margin of the diseased areas, it was not possible to observe fully the control work done within those areas, but at the margins of areas where Federal scouting was done, information was obtained in local control activities. In most cases the removal work consisted of destruction of material tagged by Federal inspectors and, because the Federal scouting was for quarantine purposes and was not aimed at finding all diseased elms, only a portion of the hazardous material was destroyed.

The States of Massachusetts, Maryland, Virginia, Indiana, and Delaware removed all Dutch elm diseased trees and some of the bark beetle material found by Federal scouts. Connecticut secured the destruction of Dutch elm diseased trees located at the eastern limits of the major disease region. New York conducted a local control program in selected parts of the major disease region, but did very little at the margins. New Jersey did similar work in the center of the infected area but had no marginal problem to handle during the year. Pennsylvania, Ohio, and West Virginia had no organized program for the destruction of hazardous material during the past year. The Gettysburg National Park removed a diseased tree and likewise some beetle infested material on Park property. Ohio is considering a State quarantine for the known disease area in that State. Rhode Island and Vermont have done or are planning some scouting for the disease.

Experimental control work to determine what action may be taken by cooperating agencies to protect valuable elms in areas of general infection: In the absence of an area-wide control program, local control efforts are essential to the protection of valuable elms in areas of general infection. As provided for in the appropriation act for fiscal year 1945, test plots were established to evaluate various control methods with respect to their practicability and effectiveness when used by property owners and local agencies to reduce losses due to the Dutch elm disease. These tests were conducted under the technical direction of Bureau workers. Two plots of about 25 square miles each and one plot of about 10 square miles were established to test the effectiveness and economy of thorough scouting and sanitation as well as scouting, sanitation and bark beetle trapping when applied to small areas within the generally infected area. Nine small control plots

were established around one or more valuable elms to test the effectiveness of local control work. Thirty small study centers around individual diseased trees were surveyed to determine the hazard of spread of the disease, existing under uncontrolled conditions.

It is not expected that significant results can be obtained from the large and small control plots until three or more years' work has been completed. Of the 30 study centers, 4 showed no increase in disease; 24 showed an average increase of 600%; one plot developed 80 new cases; and one plot produced about 130 new Dutch elm disease trees in one year.

The fiscal year 1946 work program provides for the continuation of all of the experimental plots on the same basis as last year. An increase in the number of small control plots is desirable and will be attempted if work in the large plots will permit.

Identification of disease in trees suspected to be infected with the Dutch elm disease: During the fiscal year 1945, 10,025 specimens from elm suspects were collected on quarantine scouting and were cultured in the laboratory. Of these, 711 were found to contain the Dutch elm disease fungus, C. ulmi. Similar figures for fiscal year 1944 were 13,293 specimens and 927 confirmations. In addition, during fiscal year 1945 the laboratory cultured 516 specimens and obtained 347 confirmations from experimental plots and from cooperative and other collectors. Similar work in fiscal year 1944 involved 934 specimens and produced 809 confirmations.

Continued progress has been made in developing methods of culturing bark beetle material to detect the possible presence of C. ulmi. As a consequence, about 60% of all specimens sent to laboratory in fiscal year 1945 were of this type. This technique often yields evidences of the presence of the Dutch elm disease fungus in areas before it would ordinarily be detected through finding symptomatic trees. It also shows the meance of undestroyed bark beetle material at the margins of the disease areas. In order to secure greater returns from scouting, the amount of material cultured from each sample taken by the scouts has been increased on an experimental basis and this procedure may soon be adopted as a regular practice. The use of low temperatures in culture incubation rooms has been found to produce improved results. The plating on agar media of discolored wood specimens will be continued as in previous years. This type of sample is taken most commonly from trees in the experimental control plots where the Dutch elm disease has been well established for several years.

During fiscal year 1945 the laboratory identified C. ulmi. in specimens submitted from Canada where the Dutch elm disease was not previously known to occur. The same amount of identification work will be required for fiscal year 1946, and attempts to improve culturing techniques so as to obtain more positive results will be continued.

Quarantine enforcement: The almost complete stopping of control work in some states, after removal and destruction of the elm on Federal funds was discontinued, increased the importance of quarantine measures, intended to reduce the movement of hazardous elm material from

neglected disease areas to areas free of the disease. In order to reduce to a safe minimum the restrictions on elm movement efforts to provide means for certifying regulated articles were continued.

The project cooperated with three States in attempting to develop greater demands for elm products for commercial uses. Increased commercial uses should contribute to the removal and destruction of much hazardous elm and at the same time provide some encouragement through monetary returns to property owners and local agencies. At the present time no definite increases in demands have been developed, but the prospects are promising enough to warrant a continuation of the effort in fiscal year 1946.

For the purpose of learning something of the traffic that may develop, a preliminary survey was made of the movement and uses of elm in the quarantine regulated areas and in the adjacent non-regulated areas by inspectors assigned to scouting at the margins of the infected areas.

The extent to which the change to a permissive type of quarantine will increase the quarantine operations costs in fiscal year 1946 cannot be fully determined now. When labor conditions and transportation facilities improve, there may be a significant increase in the movement of restricted elm trees and products. Because the size of the regulated area will be increased from 11,617 square miles to approximately 20,000 square miles by the proposed quarantine revision, the amount of hazardous movement is also potentially higher.

Surveys to determine where the Dutch elm disease occurs as a basis for quarantine enforcement: Surveys were made in zones 20-miles wide beyond the margins of known diseased areas to (a) detect the Dutch elm disease beyond known limits of established infections, (b) determine the nature and extent of elm bark beetle infestations, and (c) record the distribution and condition of elms in the areas surveyed. In connection with the surveys, contacts were made with local agencies and property owners to acquaint them with Federal and State activities and to supply information and suggestions on Dutch elm disease control by local efforts.

Very little time was available to conduct exploratory surveys at old locations, where Dutch elm disease is considered inactive, and in areas far removed from known disease but possibly exposed through the movement of imported as well as native elm material. Limited surveys were made along the New York Central Railroad and in the area of bark beetle infestation around Rochester, New York; along the Ohio River in Indiana and Kentucky; in the vicinity of the old Dutch elm disease area at Cleveland, Ohio; in eastern Massachusetts; along the Potomac River between known Dutch elm disease areas in Maryland, Virginia and West Virginia; and in the Susquehanna River Valley below Wilkes-Barre, Pennsylvania.

During fiscal year 1945, two partial surveys were made covering about 26,000 square miles of territory around known infected areas. This work resulted in the addition of 229 minor civil divisions and about 6300 square miles to the known Dutch elm disease areas in Connecticut, Delaware, Indiana, Maryland, Massachusetts, New Jersey, New York, Ohio, Pennsylvania, Virginia and West Virginia. The results of similar work

during fiscal year 1944 were the addition of 137 minor civil divisions and 4007 square miles. The more significant linear mile extensions were: 22 miles east in Connecticut; 18 miles north in Massachusetts; 30 miles north in New York, and 35 miles west in Pennsylvania. An infection was found 50 miles below Wilkes-Barre, Pennsylvania along the Susquehanna River. A 15-mile southward extension from Pennsylvania reached into Delaware. These extensions are more than double the extensions found in any previous year. The Athens, Ohio disease area was extended 20 to 25 miles in all directions except to the north where a 12-mile spread was found. The Frederick, Maryland area was found to extend north into Pennsylvania and south into Virginia. No important extensions were found from the Indianapolis, Ind., and Cumberland, Md. areas. No new Dutch elm disease areas or new activity in inactive Dutch elm disease areas were found by the limited amount of exploratory work beyond the regular work areas.

7. Phony Peach and Peach Mosaic Eradication.

General Statement: In cooperation with States, the general work plan is to inspect host trees; to secure removal under State authority of those found infected; to inspect nurseries and budwood sources and their environs, and make recommendations to the States relative to certification of those nurseries found free of disease; and to assist State officials in enforcing quarantines. The program followed for the past several years is predicated on (a) protection of nurseries by rigid annual inspections to prevent local or long-distance spread of the diseases to new or cleaned-up areas through the medium of nursery stock; (b) eliminating the last traces of the diseases from counties or States in which only light infections remain; and (c) protecting, insofar as practicable, commercial areas in order to permit economic peach production, and to reduce and ultimately eradicate the disease from such areas.

Control Program: During the 1944 calendar year, 239 nurseries growing more than 5,000,000 stone fruit trees and 54 budwood sources affected by these diseases, together with their environs were thoroughly inspected and protected. Two nurseries in the phony peach area and 3 in the peach mosaic area failed to meet certification requirements because of exposure to these diseases. State quarantine regulations will prevent movement of nursery stock from these nurseries. This type of nursery protection has been conducted for 10 years. During that period there has been no recorded instance of disseminating these diseases through nursery stock or budwood which represents the only known methods by which these diseases can be artificially disseminated, and it is believed that this work has stopped the further long-distance spread of these diseases.

During the year, the State of Illinois and additional counties in other states in which all known infections have been eliminated were removed from quarantine restrictions. A very thorough inspection of peach growing areas in over 20 states was made 10 years ago. All infections discovered at that time have been eliminated from 7 lightly infected states. However, no thorough inspections elsewhere in these states have been made subsequent to that time and undiscovered incipient infections may exist in these states.

During the 1944 calendar year orchard inspections for the phony peach and peach mosaic diseases were made in 243 counties in 16 southern and southwestern states extending from South Carolina to California. Over 11,000,000 orchard trees were inspected and 72,053 trees in 80 counties were found to be infected with these diseases. Practically all of these trees were promptly removed through the extensive cooperative effort of growers, counties, and states. The incidence of peach mosaic in the extensive commercial peach growing areas of southern California and western Colorado, where annual inspections and prompt removal of diseased trees have been effected, has been very greatly reduced; the economic loss is much lighter than in previous years; and the growers are highly encouraged over the possibility of ultimate eradication.

Activities directed towards the control and suppression of the phony disease in the heavily infected, extensive commercial areas of Georgia and Alabama have been restricted to inspections of commercial orchards and reflected some increase in the incidence of phony disease over that of the previous year. There were 63,231 diseased orchard trees found infected in these two states, all of which were promptly removed through grower cooperation. Factors contributing to this increase include (1) inadequate inspection of dooryard plantings and trees in towns and villages interspersed throughout the commercial areas where diseased trees in infective distance of the orchards are known to occur, and (2) inability to make inspection of trees in commercial orchards annually which permitted a build-up of infection during the years when diseased trees were not discovered and removed. However, the suppressive measures as being conducted are holding the number of infected trees to approximately one-third the number which occurred in these orchards a number of years ago when control work was undertaken.

8. Barberry Eradication.

General Statement: Barberry eradication is carried on by the Bureau in cooperation with 18 States. Close working relations are maintained with interested Federal, State and local agencies, including those engaged in breeding new and improved rust-resisting grains. Within the States the work is organized under State leaders, who plan, direct and coordinate the activities of all cooperating agencies so as to clear definite areas of barberries. Timbered areas, stream banks, fence rows, and other uncultivated lands are systematically examined for barberries and the infested areas are mapped. The bushes are eradicated by treating them with salt or other chemicals, or by grubbing. Initial eradication is carried on in unworked areas. Previously treated areas are reworked as needed at about five year intervals until all danger of regrowth from sprouts and seeds has passed. Surveys are conducted each year to determine where and to what extent stem rust is causing damage to grain crops. The distribution and planting of susceptible barberries in cooperating States is prevented by quarantine regulations. Nurseries are encouraged to grow only immune varieties for the trade and to cooperate voluntarily in eliminating their rust-susceptible barberries. The eradication program is supplemented by educational work to inform property owners about stem rust and its control and to obtain their active cooperation in locating and destroying barberry bushes.

Control Program: Destructive epidemics of stem rust, which occur periodically, and annual local losses of importance have caused this disease to be recognized as a serious hazard to the profitable production of wheat, oats, barley and rye. The economic importance of these crop losses has stimulated vigorous application of stem rust control measures which include barberry eradication, the use of improved resistant varieties of grain, and early sowing of spring grains. As a result, stem rust losses have been reduced from an average of 48,000,000 bushels annually for the 14-year period 1915-1928 to 24,000,000 for the 14-year period 1929-1942. This reduction represents a saving to farmers conservatively estimated at $20,000,000 annually. In addition, stem rust control measures have resulted in larger per acre yields of better quality grain and in a more stabilized food supply. This has been of special value during the war, as it permitted increased consumption of cereal crops for food and feed, and for production of industrial alcohol.

During the calendar year 1944 and much of 1945 war conditions continued to have a retarding effect on barberry eradication and field work was directed toward holding the progress already made as far as practicable. Labor was obtained from the younger and older age groups and included high school students, teachers, older men incapacitated for work in industries, discharged veterans, and farm workers who were available between the busy farm seasons. The flexibility of the work program made it possible to shift from one locality to another and increase or decrease the work load as the number of available laborers changed from time to time. With barberry bushes "coming back" on large numbers of previously worked properties, and many areas in danger of reinfestation, needed rework was given first consideration. Initial work was confined to the State of Washington, and a few places in Colorado, Virginia, and West Virginia. The work program has not been large enough to make much progress toward completion of the initial eradication, nor to keep up with the rework which since 1942 has fallen behind schedule in areas aggregating 33,365 square miles.

The survey and eradication work in 1944 resulted in the destruction of 1,094,726 barberry bushes on 2,910 properties in 219 counties of the 18 cooperating states. Of these bushes 76,067 were the common barberry and the remainder native species. The eradication work involved complete coverage of areas totaling 10,384 square miles and included rework of 10,367 properties, of which 1,804 or 17 per cent were found to be reinfested with barberry bushes. Of the properties reworked, 3,365 are considered free of bushes and will require no future work. In addition, bushes were located on 1,106 new properties. A summary of the results of the eradication work, by states, is shown in Table 1.

Special features of the year's work included an extensive resurvey of 6 counties in northeastern Montana, which were originally worked in 1924. This area was found to be free of barberries and is now considered completed. In the State of Washington cooperative barberry eradication operations were started July 1, 1944, and work was conducted in Whitman, Spokane, Garfield, Lincoln, and Adams counties. Including some work done by State and county crews prior to July 1, 1944, a total of 21,404 barberry bushes was destroyed on 398 properties in Whitman and Spokane counties in areas covering 786 square miles.

Scattered bushes were located in the other three counties by reconnaissance surveys. At the request of interested State and local agencies in Kansas, a preliminary sampling survey was carried out in 27 counties, in cooperation with the State Entomological Commission, to obtain information on the occurrence and distribution of barberries. A total of 1,085 barberries was found on 137 properties and 762 of the bushes were fruiting. Escaped bushes were observed on two properties. These results are indicative of barberry conditions in Kansas. In Minnesota, 74 counties authorized or renewed authority for bounty payments on locations of rust-susceptible barberries. During the year, bushes were destroyed in 25 reported locations, for which bounties were claimed.

Since the barberry eradication program began, over 313,695,675 bushes have been destroyed on 129,177 properties. Of these, 47,472 are within areas now on a maintenance basis. Some of the remaining 81,705 properties will require only one more inspection, but most of them are in generally infested areas where continued effort will be necessary to complete their elimination. About 68 per cent or 738,213 square miles of the 1,078,201 square miles within the barberry eradication area comprising 18 of the more important grain growing States is now practically free of rust-susceptible bushes, and has been placed on a maintenance basis. This involves nearly all of South Dakota and Wyoming, and most of the area represented by the States of Montana, Missouri, Nebraska, North Dakota, and Indiana. The remaining 339,988 square miles requiring barberry eradication work is largely in States bordering or east of the Mississippi River. It consists of 129,059 square miles of initial work and 210,929 square miles needing rework one or more times. In some areas, where the original bushes are abundant and have existed for many years, several periodic workings will be necessary to complete the eradication, while one or two will be sufficient for those areas with a few scattered bushes. Of immediate importance are areas last worked about 6 years ago or earlier, which were originally heavily infested with barberry bushes. These areas should be reworked immediately, because they have become reinfested with bushes now old enough to produce berries and reseed the area. Regrowth in these areas comes from barberry seeds, which may persist in the soil and germinate over a period of 10 or more years. Since these new bushes are able to produce seed when about 5 to 6 years old, their systematic removal must be performed at the proper time interval to preclude seed production and reinfestation of worked areas. Table 2 indicates the present status of the barberry eradication program.

No general epidemic of stem rust developed in 1944, although severe local and regional epidemics caused considerable damage and loss to grain in northern Kansas, northeastern Colorado, southeastern Wyoming, and parts of Nebraska and South Dakota. Very little rust developed on bread wheats in the spring-wheat area where resistant varieties such as Rival, Regent, Renown, and Thatcher were extensively planted. East of the Mississippi River the aggregate amount of damage was negligible. Barberries began to rust heavily in Virginia and certain other States, but seasonal drought almost completely checked rust development.

Just as there are many varieties of wheat, oats, barley, and rye, there likewise are many varieties and races of the stem rust fungus. Certain varieties of grain are highly resistant to some of these races, but very susceptible to others. New races are produced and old ones perpetuated on the leaves of barberry bushes. Thus the removal of barberries reduce the opportunity for the fungus to develop new races capable of attacking new and improved varieties of grain. The most prevalent races of the wheat variety of stem rust identified during 1944 were 56, constituting about 44 per cent of all isolates; race 38 with 27 per cent; race 17 with 21 per cent; and race 19 with 7 per cent. The following races were present in only small amounts: 14, 24, 36, 40, 49, 59, 139, and 142. The predominance of race 38 in the East and race 56 in the West was less pronounced than in the previous two years.

From 84 aecial collections of stem rust on barberries, 16 races of the wheat variety of stem rust were obtained. Since there were two or more biotypes of several of the races, 21 distinct lines were identified from this relatively small number of collections. A study of the prevalence and distribution of races of stem rust in Mexico showed no important changes.

Races 2 and 5 of the oat variety of stem rust constituted 67 per cent of the isolates, while races 8 and 10 made up 33 per cent. This represents an increase in prevalence of races 8 and 10 of 13 per cent over that of 1943, which may be significant, since these two varieties attack Boone, Tama, Vicland, and several other heretofore resistant varieties of oats, most of which were derived from Victoria x Richland crosses.

Applications to ship barberry and mahonia plants under the provisions of Federal Quarantine No. 38 were received from 35 growers during the calendar year. Permits were granted to 13 on the basis of the 1944 inspection, and 22 were given permits without inspection after a review of previous inspection records. Nineteen nurseries that had not requested permits were visited or contacted through correspondence and encouraged to remove their rust-susceptible barberry stock and to cooperate with the stem rust control program by propagating and offering for sale only immune or resistant varieties in the future. These nurseries agreed to cooperate in this manner.

Table 1 - Results of barberry eradication work, calendar year 1944

State	Area Surveyed	Properties Cleared		Bushes Destroyed		
		New	Old	Berberis vulgaris	Native Species *	Total
	(sq. mi.)	(No.)	(No.)	(No.)	(No.)	(No.)
Colo.	349	61	169	5,676	390,725	396,401
Ill.	450	65	78	1,496	- -	1,496
Ind.	362	4	39	516	384	900
Iowa	549	38	128	1,768	- -	1,768
Mich.	816	250	326	7,347	- -	7,347
Minn.	665	40	72	2,776	- -	2,776
Mo.	1,146	32	17	176	- -	176
Mont.	2,088	0	0	0	- -	0
Nebr.	296	4	2	6	- -	6
N. Dak.	1,162	0	2	15	- -	15
Ohio	461	59	159	4,049	- -	4,049
Pa.	20	5	93	24,649	- -	24,649
So. Dak.	185	1	0	1	- -	1
Va.	165	41	125	0	442,951	442,951
Wash.	787	398	4	21,404	- -	21,404
W. Va.	48	0	149	202	184,599	184,801
Wis.	835	108	441	5,986	- -	5,986
Wyo.	0	0	0	0	- -	0
Totals	10,384	1,106	1,804	76,067	1,018,659	1,094,726

* B. fendleri A. Gray and B. canadensis Mill.

Table 2 - Status of Barberry Eradication through 1944

STATE	SQUARE MILES			NUMBER OF PROPERTIES WITH BARBERRIES		
	In control area	On maintenance	Unworked or requiring rework	Cleared to date	On maintenance	Requiring rework
Colorado	74,685:	70,299:	4,386:	2,764:	1,273:	1,491
Illinois	56,043:	34,666:	21,377:	19,588:	5,867:	13,721
Indiana	36,045:	26,310:	9,735:	6,886:	4,527:	2,359
Iowa	56,167:	30,507:	25,660:	15,187:	5,956:	9,231
Michigan	57,481:	38,734:	18,747:	17,415:	8,996:	8,419
Minnesota	80,883:	28,105:	52,778:	8,865:	4,400:	4,465
Montana	146,316:	142,922:	3,394:	637:	300:	337
Nebraska	77,268:	63,146:	14,122:	4,801:	4,035:	766
North Dakota	70,183:	65,453:	4,730:	1,074:	901:	173
Ohio	40,740:	24,657:	16,083:	17,015:	5,124:	11,891
South Dakota	76,868:	67,454:	9,414:	1,495:	1,160:	335
Wisconsin	54,852:	14,430:	40,422:	16,997:	4,431:	12,566
Wyoming	94,487:	94,383:	104:	125:	55:	70
Subtotal	922,018:	701,066:	220,952:	112,849:	47,025:	65,824
Missouri	36,016:	21,682:	14,334:	1,378:	445:	933
Pennsylvania	27,073:	4,261:	22,812:	8,682:	- -:	8,682
Virginia	11,821:	1,418:	10,403:	3,844:	2:	3,842
Washington	66,977:	- -:	66,977:	398:	- -:	398
West Virginia	14,296:	9,786:	4,510:	2,026:	- -:	2,026
Subtotal	156,183:	37,147:	119,036:	16,328:	447:	15,881
GRAND TOTAL	1,078,201:	738,213:	339,988:	129,177:	47,472:	81,705

9. Pink Bollworm Control.

General Statement: The purpose of this program is to prevent the spread of pink bollworm to uninfested cotton-growing areas of this country from infested areas in the United States and adjacent areas in Mexico. This is being accomplished by (1) suppressing and preventing spread of pink bollworm infestations in the United States and bordering areas in Mexico; (2) the eradication of wild cotton in Florida which serves as a year-around host for the pink bollworm if left undisturbed; and by (3) cooperating with Mexico in the application of regulatory and suppressive measures in pink bollworm infested areas located adjacent to or bordering the United States.

Full-time employees are located in Arizona, Florida, New Mexico, Texas, and Mexico, with field headquarters in San Antonio, Texas. District and sub-district stations are maintained within the regulated areas at places conveniently accessible to the growers and cotton processors and shippers. Project headquarters for the Mexican cooperative work is at Monterrey, Nuevo Leon, Mexico. The administration of the program is on a work project basis, each work project embracing a main objective of the program.

These activities are all conducted in cooperation with State agencies, other federal agencies, farmers, agricultural associations, and organizations representing cotton growers, processors, exporters, and other local agencies. An important phase is the control work carried on cooperatively with the Agricultural Department of the Republic of Mexico, which contributes the services of some 30 employees, together with equipment and incidental expenses. This work has been greatly strengthened by assignment on invitation of the Mexican authorities of Bureau personnel long experienced in pink bollworm control to the cooperative program in an advisory capacity in the interior cotton-growing regions of Mexico. A similar type of cooperation is received from the various cotton-producing States, while processors, ginners and farmers make substantial contributions to the work by incurring the extra expense involved in treatment of products to make them safe for movement out of the quarantined area, sanitation of premises, segregation of products at ginning plants, destruction of cotton stalks, controlled planting and other practices, which would not be necessary in the normal course of their operations but which are willingly undertaken as a part of the effort directed against the pink bollworm.

Suppression and prevention of spread of the pink bollworm: The application of suppressive and spread preventing measures includes (1) inspection to determine the extent and intensity of infestations, (2) the enforcement of regulatory measures governing the movement of cotton and cotton products from infested to uninfested areas, and (3) the prompt destruction of cotton plants in infested areas following harvest to create a host-free period during a part of the year, and the application of insecticides.

(1) Inspections of the 1945 cotton crop for pink bollworm were made in Florida, Georgia, Alabama, Mississippi, Louisiana, Texas, New Mexico, Arizona, California, and in the principal cotton-growing sections of Mexico. The bulk of this work consisted of gin trash inspection but it was extensively supplemented by inspection of cotton blooms and bolls in the field and laboratory. About 40,000 bushels of gin trash were inspected by the end of September, 1945.

Outside of the quarantined area new infestations of pink bollworm were discovered in the following Texas Counties: Medina, Liberty, and Chambers. These newly infested counties do not indicate a serious spread of the infestation but adjoin counties in which infestation was discovered in 1944. Intensive inspections in areas adjoining the infestation found in 1943 in the Louisiana Gulf coast region were negative.

Within the regulated area a decrease in degree of infestation was found in Cameron and Hidalgo Counties in the lower Rio Grande Valley and a general but light infestation in the Coastal Bend area. However, the infestation was not found to recur in the southwestern Louisiana zone found infested in 1943 nor in Brazoria and Matagorda Counties in Texas. Nearly all of the counties of the Panhandle Quarantined district of Texas were found to be lightly infested, whereas in the past several years infestation has been absent in most of these counties. The irrigated valleys of West Texas showed an increase of infestation, particularly in the El Paso Valley where the increase was rather pronounced. There was apparently little change in the degree of pink bollworm infestation in the Arizona and New Mexico areas under quarantine. There was no change in Thurberia weevil infestation in Arizona.

(2) The purpose of the regulatory work is to prevent the spread of the pink bollworm and Thurberia weevil to new areas, to prevent build-up in known infested areas by the supervision of processing plants, to immediately institute quarantine and regulatory procedures if and when new areas are found to be infested, and to issue permits authorizing the movement of treated cotton and cotton products from regulated to free areas after they have been treated in such manner as to render them free of any pink bollworm and Thurberia weevil that might be present and subsequently kept free from contamination. The required treatment and certification of cotton and its products require a great amount of supervision of a large number of processing plants and individuals under dealer-carrier permit engaged in the ginning, handling and processing of cotton and its products. Due to the feeding habits of the pink bollworm larvae, the principal means of artificial dissemination is through movements of cottonseed. Consequently, prior to certification, cottonseed must be heated to 150° F. for a reasonable period to kill any pink bollworm therein. Lint cotton must be roller treated, compressed, or otherwise treated and subsequently handled under sanitary conditions. Gin trash and other debris must be treated or burned to kill all pink bollworm therein and to eliminate favorable places of hibernation.

The discovery of additional infestations in southern and northwestern Texas during the crop year 1944, together with the new discoveries of 1943, added 275,000 acres of cotton to the cotton acreage in the infested area in Texas. Involving 28 additional counties it materially increased the length of the quarantine line. It also brought the infestation that much nearer to the main cotton-producing areas of the State. It was necessary to provide supervision for an additional 277 gins located in the newly added counties. Supervision by inspectors was also required for 12 additional oil mills and for 7 compresses. It is estimated that 10,000 inspections will be required to adequately supervise activities at these 296 processing plants most recently added to the regulated area. The infestations were discovered so late in the season that it was impossible to install cottonseed heating equipment in the gins at that time. However, the new areas were placed under emergency quarantine by proclamations of the Governor of Texas immediately after such discoveries, and all cotton subsequently produced was ginned within the affected areas. Cottonseed moved to

designated mills only for treatment by heat upon arrival. Cotton moved under permit to designated compressers for treatment, and other regulatory procedures were administered as effectively and efficiently as possible under the circumstances. In the newly infested south Texas areas some 3,000 tons of cottonseed in the possession of approximately 2,700 individuals were treated for planting this spring. An additional 2,500 tons in the possession of growers were disposed of through feeding or sales to designated oil mills, where it was treated upon arrival. 1,500 tons of seed were treated by cotton breeders in this newly infested area under close supervision of personnel of the division.

During the season of 1944-45, 1,041,922 bales of cotton were ginned at 694 gins designated and under permit to gin cotton produced within the regulated area. 468,863 tons of cottonseed were given the heat treatment, in addition to the tonnage heated by seed breeders and for the cotton growers mentioned above. A total of 51 cottonseed oil mills were under dealer-carrier permit. 8,461 bales of linters from the Republic of Mexico were vacuum fumigated. 459,382 bales of cotton and 4,144 bales of linters were compressed at 12 compresses operating under dealer-carrier permit and located within the regulated area. Additional progress was made in connection with the administering of the heat treatment of cottonseed in the older infested areas. Inspections of processing plants were held to a minimum, in accordance with necessary conservation of mileage, but through study and the institution of a better system of checking results, efficiency was maintained in these old regulated areas. A total of 23,179 inspections were made of plants and premises of cotton processors in the regulated areas under dealer-carrier permit, exclusive of the newly infested territory in south Texas.

(3) The control operations have for their object the reduction in pink bollworm populations by cultural methods and the use of insecticides. In south Texas the cotton plant will remain alive and continue to fruit throughout the year if left undisturbed. It is, therefore, necessary to destroy the cotton plants promptly following harvest in order to eliminate the continued breeding of the pink bollworm late in the season which results in a marked build up in populations and which contributes to overwintering of the larvae. Consequently, the pink bollworm program in south Texas and adjacent areas in Mexico involves prompt destruction of the cotton stalks, following harvesting of the crop and in no event subsequent to a specified date established by State regulation in Texas and by competent authority in Mexico. During past crop season the State of Texas issued regulations requiring destruction of cotton plants at dates of September 15 or later. Continued heavy rains which usually come late in August or early in September have prevented the farmers meeting the dead-line dates because of inability to go into the cotton fields with heavy equipment used in destroying stalks and plowing out the roots. The advantage of early destruction of cotton plants, particularly in the lower Rio Grande Valley, has become well recognized however that the date for destruction of the plants subsequent to harvest was established for the 1945 crop as of August 31. The cotton acreage involved in the

lower Rio Grande Valley of Texas is approximately 275,000 acres and there is an estimated 200,000 acres devoted to the production of cotton in adjacent areas of Mexico.

Appropriate dates were established for the destruction of cotton stalks subsequent to the harvest in the remaining counties of south Texas located outside of the lower Rio Grande Valley. Heavy rainfall likewise has previously prevented the realization of the program in these other counties in south Texas.

The control program in the Big Bend of Texas for the crop year 1945 involved the application of the new insecticide DDT as a suppressive measure. Several applications were made at intervals during the season to afford an opportunity to determine the results of large scale applications of this material as it proved to be very effective in suppressing the pink bollworm and on the basis of the results obtained the usual fall clean-up operations were omitted. It is planned to make use of this insecticide in that area in 1946.

The spread of the pink bollworm infestation to additional counties in south Texas during the late summer and early fall of 1944 resulted in adding 275,000 acres of cotton land on which pink bollworm control measures had to be inaugurated. Consequently, cultural control programs, including cotton stalk destruction to create a host-free condition in sub-tropical areas; cotton field clean-up, involving the cutting, raking, piling and burning of cotton stalks and shattered debris; and deep plowing are now being practiced on approximately 750,000 acres in areas infested or exposed to pink bollworm infestation. By far the greater portion of this acreage is in the infested area of Texas lying south of the Southern Pacific railway. The Bureau is active in connection with the control program on all of this acreage and, in instances where infestation creates a distinct menace likely to result in spread of the insect to new areas, the Bureau participates in cooperation with the State and local growers in intensive cotton field clean-up or other measures designed to suppress or eradicate the insect.

Partly for experimental purposes to learn more about the use of DDT in pink bollworm control and partly because of the urgent need to reduce pink bollworm populations in the lower Rio Grande Valley area during the season of 1945, several applications of this insecticide were made in fields which were believed to be more heavily infested on the basis of early season inspections. While DDT is not particularly effective against the boll weevil and certain other cotton insects, it affords for the first time an insecticide which may be used against the pink bollworm with reasonable expectation of successful results.

Eradication of wild cotton in Florida for protection of the cultivated cotton from pink bollworm: It is the purpose of the work performed under this project eventually to eradicate the pink bollworm in southern Florida through the elimination of wild cotton which serves as its host in that area. This will remove a distinct hazard in connection with the possible spread of the pink bollworm to the main cotton belt of the United States.

The wild cotton grows continuously throughout the year and it is necessary to conduct intensive surveys of areas closely adjacent to those where wild cotton is known to be present. This is particularly essential in south Florida where the tropical hurricanes occur periodically and which in the past have been known to spread mature wild cotton bolls and open locks of seed cotton, thereby starting a growth of these plants in areas formerly free of them. So long as wild cotton bolls are permitted to mature and open there is a strong likelihood of dispersal of seed to new areas. There are hundreds of miles of shoreline on the mainland of Florida and on the Keys or islands in the Bays on which wild cotton thrives. It is necessary because of the tropical vegetation to cover the area in a very intensive manner with trained scouts on foot. Progress of scouting is extremely slow due to the necessity of cutting through heavy undergrowth to reach the natural clearings where the wild cotton plants flourish. Of the plants removed in the fiscal year 1945 somewhat more than 8,000 carried mature bolls as compared with more than 25,000 having mature bolls in the year immediately preceding.

It is proposed to conduct an intensive survey of all areas adjacent to known locations of wild cotton. Particular emphasis will be given to a most thorough coverage of the areas which have been visited by tropical hurricanes during the past several years. New trails will have to be cut and undergrowth cleared away in order to reach almost inaccessible areas in which seed may have been carried by wind or high water. In order to prevent fruiting of wild cotton the areas must be covered and recovered during the course of the year. If too long a period elapses between the last cleaning in the late spring and resumption of the work in the fall a crop of wild cotton bolls will be produced, mature and shed seed cotton on the ground, resulting in a new crop of seedling plants. It is planned to cover all of the area three times each year, digging or pulling out the plants before sufficient time has been allowed them to produce bolls. All of this involves the organization of small crews of scouts, larger crews of laborers, and their transportation, and maintenance in areas remote from the populated areas of the State.

Important obstacles in this work have been that the work in south Florida is limited at the beginning of the season by excessive moisture and the work is obliged to be terminated before unfavorable weather begins in the spring because of the prevalence of pest mosquitoes. It is believed that progress made in controlling annoying mosquitoes will enable us to prolong the season until the coming of the rains makes further seasonal work impracticable.

Cooperation with the Mexican Government to control pink bollworm infestations to prevent spread into the United States: The purpose of this work is to prevent spread of the pink bollworm to additional areas of the United States by securing the most effective possible cooperation with the Mexican Department of Agriculture and local agencies in carrying on more extensive and comprehensive programs in connection with suppression of the pink bollworm in Mexican areas.

It has been reliably estimated that above 90% of the pink bollworm population in the cotton on the North American Continent is to be found in the Laguna and Delicias cotton-growing regions of Mexico. The creation of a host-free period in the Border area of the United States would largely be nullified if the Mexican authorities permitted their growers to allow cotton to continue growing and breeding pink bollworms. It, therefore, is vital to the United States that Mexico apply stringent pink bollworm suppressive measures. Since the effort to secure greater cooperation between the two governments/began, there has been progress in the control program in effect in the two countries. As this develops, the value of the work conducted solely on the American side of the Border is expected to increase. In general the problems of controlling the pink bollworm in the two countries closely parallel each other, with the very distinct difference that practically all of the important cotton-growing areas of Mexico are already infested whereas only about 5% of the United States cotton area is infested.

The plan now being followed in Mexico involves the use of trained employees of the Bureau, not only in the areas immediately adjacent to the Border but in the great cotton-producing regions further south which complicate control along the Border. Bureau employees work directly with appropriate national and local Mexican officials in all phases of pink bollworm control including educational work with growers and processors.

10. Transit Inspection

General Statement: Inspection is conducted at transportation centers throughout the country. At principal transportation centers operations are on a year-around basis while seasonal work is conducted at certain other points where the volume of work is heavy during a particular shipping season. While most of the inspectors are on the Federal rolls, cooperating agencies in the States usually assign about 12 men to assist in this work. Substantial assistance is also given by the cooperation of several thousand mail, express, and freight employees who watch for shipments of restricted materials and hold them for examination by the inspectors.

Assignments are frequently changed, new stations opened, or old ones discontinued to meet the inspection requirements occasioned by changes in quarantines or in regulated areas.

Inspection program: More than 2,600,000 shipments of plants and other articles, the interstate movement of which is regulated by Federal domestic plant quarantines, were inspected, during the fiscal year 1945, at 20 transit inspection stations located at the most strategic redistribution centers of common carriers.

Through May 31 of that fiscal year, 1,778 violations of seven of the nine Federal domestic plant quarantines were found. Some of these were inspected and allowed to proceed upon determination that no pest hazard was involved and others returned to the shipper if inspection was impractical or a definite/pest hazard was found to be present. Twenty-five

shipments were found to be moving in violation of the regulations governing the movement of plants into the District of Columbia and 630 shipments reported to state pest control officials as apparent violations of state nursery inspection or other plant pest regulation.

During the past year, it has been possible for transit inspectors at 6 stations to cooperate with the Division of Foreign Plant Quarantines in the inspection of airplanes of foreign origin and overseas soldier mail. The recent establishment of several inland points of first call for airplanes of foreign origin and the great increase in soldier mail, coupled with the manpower shortage, has complicated the problem of inspection of these important potential sources of pest introduction.

As a result of an outbreak of Mexican fruitfly in citrus groves in the Lower Rio Grande Valley of Texas during the spring months of 1945, sterilization of grapefruit was required as a condition of movement. To assist in the prevention of movement of unsterilized grapefruit the staff of transit inspectors was increased at Houston, the most important redistribution center for fruit moving from the areas regulated on account of the Mexican fruitfly.

In July and August of 1944, during the period when certification is required on fruits and vegetables moving via refrigerator cars and motor trucks from the heavily infested Japanese beetle regulated area, inspection was conducted at two important interchange yards in Ohio through which refrigerator cars from that area move. One thousand one hundred and seventy-nine refrigerator carloads of produce destined to 185 cities in 22 states were inspected. Forty-six carloads consigned to 29 cities in 9 states were found to be moving in violation of the regulation. Treatment was required before these cars were allowed to proceed.

The program for the current year includes: (1) Increase where possible in cooperation with the Division of Foreign Plant Quarantines the inspection of soldier mail and planes of foreign origin at inland points; (2) assignment of inspectors permanently to all strategic points wherever possible within the limit of available funds; (3) resumption of inspection of refrigerator carloads of produce from the heavily infested Japanese beetle regulated area at important interchange yards during the summer of 1945.

(d) Foreign Plant Quarantines

Appropriation Act, 1946		$1,027,000
First Deficiency Appropriation Act, 1946		+ 187,500
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+ 240,000
Total anticipated available, 1946		1,454,500
Budget estimate, 1947		1,177,000
Change for 1947:		
Overtime decrease	- 98,400	
Other decrease	- 179,100	- 277,500

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Import and permit service	26,023	28,400	28,500	+ 100 (1)
2. Inspection at ports of entry of plants and plant products regulated by plant quarantines	725,704	1,291,700	1,112,500	- 179,200 (2)
3. Certification of exports	29,766	36,000	36,000	- -
4. Overtime pay	137,471	98,400	- -	- 98,400
Covered into Treasury as miscellaneous receipts, Public Law 529	128	- -	- -	- -
Unobligated balance	4,088	- -	- -	- -
Total available	923,180	1,454,500	1,177,000	- 277,500
Transferred to "Salaries and expenses, insect and plant disease control"	+34,000	- -	- -	- -
Anticipated supplemental	- -	240,000	- -	- -
Total estimate or appropriation (1945 adjusted for comparability)	957,180	1,214,500	1,177,000	

INCREASES OR DECREASES

The net decrease of $277,500 in this item for 1947 consists of the $98,400 decrease for overtime, and the following:

(1) An increase of $100 under the project "Import and permit service" for placing on a full year basis in 1947 within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(2) A net decrease of $179,200 under the project "Inspection at ports of entry of plants and plant products regulated by plant quarantine" composed of:

(a) A decrease of $187,500 due to the fact that the estimate does not provide for the continuance in 1947 of a 1946 supplemental appropriation in this amount. The First Deficiency Appropriation Act, 1946, approved December 28, 1945, contained a supplemental appropriation of $187,500 which was occasioned by urgent inspection problems arising from the return to the United States of military personnel and equipment, a heavy volume of soldiers' mail, and the development of post-war transportation and commerce.

(b) An increase of $8,300 for placing on a full-year basis in 1947 within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(Continued on next page)

WORK UNDER THIS APPROPRIATION

Objective: To protect agriculture by administering plant quarantines and regulatory orders, issued under the Insect Pest Act of 1905, the Plant Quarantine Act of 1912, as amended, and the Mexican Border Act of 1942, to prevent the entry of insect pests and plant diseases from foreign countries, Puerto Rico, and Hawaii and control and safeguard the entry of plants, plant products, and other articles which may carry such pests.

The Problem and its Significance: The estimated average annual loss from introduced foreign insect pests of plant and plant products is $1,500,000,000. This figure does not include huge annual losses from introduced fungous, bacterial, and virus diseases of plants. It is important that every practical effort be made to prevent the introduction and establishment of additional foreign plant pests which could further impede the production of food supplies, essential crops, and the agriculture of the country as a whole.

World commerce has been completely changed by the war, and current conditions impose new problems of foreign plant quarantine enforcement. In addition to the rapid return of commercial shipping, there continues a heavy movement of the ships and aircraft, troops, and supplies of the armed forces. The exigencies of the latter movements create a set of problems peculiar to the situation which necessitate intensive supervision of the personnel and work, and constant adjustment of emphasis to meet the changes occurring from day to day.

General Plan: Under the Plant Quarantine Act most kinds of plant propagating materials, fruits, vegetables, cotton lint and related products, cereals, etc., may be imported only under permit, subject to inspection, and in some instances supervised disinfection, sterilization, etc., at the ports of entry. In Hawaii and Puerto Rico the movement of certain plants and plant products to the mainland is supervised, and certain products are treated under supervision for the prevention of the movement of injurious pests with these products. The work is organized under two general headings (a) Import and Permit, and (b) Port Inspection.

During the fiscal year 1946, cooperation from States and territories will amount to $232,800, the major contribution being from California and Florida.

Progress and Current Program:

1. Import and permit service: Conditions resulting from the war continue to make it necessary to arrange on short notice for emergency entry of various cargoes. The special arrangements include the minimum essential phytosanitary safeguards which frequently require unusual methods of handling, treatment, and routing. The year 1945 marked the beginning of some commerce not directly associated with the war effort or its aftermath, accompanied by increased interest in the commercial importation of plants and plant products, the

entry of which is regulated because of pest risk. Americans overseas include plant lovers and others interested in plants; the steady flow of plant material being sent to the United States by or for personnel in the armed services involves considerable pest risk and emphasizes the need for plant quarantine activities.

By simplification of permit procedures the plant quarantine clearance of importations of restricted plants and plant products has been expedited upon their arrival in this country. These changes are of particular benefit to the importers and to the Government as they eliminate delays. To further expedite entry and reduce correspondence to the minimum, provision has been made for the issuance, under emergency conditions, of certain types of permits at the ports of entry in connection with work performed under the project "Inspection at Ports of Entry." In anticipation of further increases in importations several leaflets were prepared in 1945 containing helpful suggestions to the importers, which will benefit the importing public by making available the experience of others in suitable methods of packing and shipping.

2. Inspection at ports of entry: Developments under this project are discussed on a functional basis, which for the immediate present at least seems more significant than the geographical treatment used in some previous years.

Airplane inspection: Safeguarding against the risk of entry of injurious foreign insect pests and plant diseases with airplanes arriving from abroad, and against the spread of destructive plant pests from Hawaii and Puerto Rico to the mainland by means of airplanes, was a major problem in 1945 and is continuing as a major problem in 1946. Inspection of airplanes from foreign countries increased 112 percent over 1944 and there was a 61 percent increase in airplane inspections for the first quarter of 1946 over the last quarter of 1945. The number of airplanes inspected in Hawaii prior to their departure for the mainland in 1945 was forty-six times the number inspected in 1942, and the current rate of increase in this activity is illustrated by the 13 percent increase in the first quarter of 1946 over the last quarter of 1945. The total of 54,000 airplanes inspected in 1945 was 30,167 greater than in 1944. Airplane inspection during 1945 required the staffing of six airports previously without this service, including the inauguration of inspection activities in Alaska due to the volume of air traffic arriving in the Territory.

The importance of airplane inspection, which is carried on at maritime, Canadian and Mexican Border ports, and in Alaska, Hawaii, and Puerto Rico, is illustrated by the finding of potential pest-bearing plant material on 7,299 airplanes arriving from foreign countries in 1945. This was despite the efforts of Army, Navy, and civilian agencies to prevent carrying such material on airplanes. The importance of this inspection is further illustrated by the fact that two-thirds of the airplane arrivals from foreign

countries landed on airports in the southern portion of the United States where, if they carry pests of tropical and subtropical origin, the conditions for successful establishment of introduced foreign insects and plant diseases would be more favorable. Civil air transport is on the increase and as civil traffic replaces traffic of the armed forces, the burden of safeguarding against pest entry rests more and more with the plant quarantine service because the controls administered with considerable effectiveness by the armed forces will be absent in civil traffic. The pre-flight inspection in Hawaii of planes departing for the mainland not only eliminates delay to important passengers and cargoes upon arrival on the mainland, but eliminates at origin the pest risk which might otherwise accompany the arrival of these planes in the continental United States. Among the pernicious plant pests found in airplanes from foreign countries were the Mediterranean fruitfly, two other species of fruitflies, and the pink bollworm of cotton. Serious plant pests of Hawaii were frequently prevented from moving from Hawaii to the mainland through the pre-flight inspection program.

Mail from military and naval personnel abroad: In 1945 the plant quarantine work associated with mail from the millions of Americans in uniform stationed in foreign countries expanded rapidly. Such mail enjoys unique customs and postal privileges which place it, by statutes, in a class apart from regular mail from foreign countries. Regular mail is examined sufficiently by customs officials to insure that practically all packages containing potential pest-carrying plant material are referred for plant quarantine inspection. This assurance is lacking for mail from service personnel. Because of special laws and rulings pertaining to mail of the armed forces only a very small part of it receives customs examination sufficient to determine whether it may contain prohibited plant material. Although large quantities of packages of this class moved through to destination without plant quarantine protection because of a lack of plant quarantine inspectors to examine it, plant quarantine inspection for this class of mail was provided, for at least a part of 1945, at all of the principal points where such mail is cleared by customs. While the personnel available inspected only a part of the huge volume, they examined 3,045,324 packages, an increase of approximately 2000 percent over 1944. There was a 74 percent increase in the number of mail packages examined in the first quarter of 1946 over the last quarter of 1945. Although the size of the armed forces' establishments abroad is rapidly shrinking, the plant quarantine problem is more acute than during the war period. The personnel abroad now have more time to collect and send home souvenirs and gifts than when fighting and, with lifting of censorship, there is now no effective enforcement of Army and Navy directives against inclusion of prohibited plant material in mail packages. The responsibility for safeguarding against pest entry with this class of mail rests, therefore, almost entirely with the plant quarantine service.

The inspection of mail from members of the armed forces abroad attains its greatest volume at maritime and Canadian Border ports although inspections in Hawaii help to reduce the load at other ports and also the pest risk. Among the pests found in the course of parcel post examination was the pink bollworm of cotton, which in some instances was addressed to the cotton-growing areas of the South, a destructive bamboo borer, the flag smut of wheat, and seven other rusts and smuts of cereals which could represent new physiologic races of tremendous importance if established in the United States.

Enforcement of the Mexican Border Act: The regulation, inspection, and fumigation, when necessary, of freight cars crossing into the United States from Mexico, as provided by the Mexican Border Act, include the problem of preventing the entry of serious plant pests without unduly impeding traffic. Acute shortages of motive equipment, aggravated by traffic congestion, combine to intensify this problem. Under normal prewar conditions the chief concern of the inspection personnel was to see that returning freight cars were uncontaminated with pink bollworm-infested cottonseed and other pest-bearing materials, Currently, however, American railway cars dispatched to Mexican destinations are, because of car shortages, being used in Mexico to haul all manner of unacceptable agricultural products, and returning equipment has been found fouled with such pest-bearing products as potatoes, mangoes, peaches, oranges and avocados. These materials have on numerous occasions yielded such formidable plant pests as the Mexican potato weevil and the Mexican fruitfly. The number of freight cars inspected in 1945 was 64,995 and the number which required fumigation as a condition of entry was 9,251. The records for the first quarter of 1946 as compared with the last quarter of 1945 show that this activity is continuing on about the same volume level. Freight car congestion in the yards on both sides of the Border at the several railroad crossings is a material concern to the operating personnel and officials of other agencies charged with the traffic between the two countries. Plant quarantine inspectors are continuously working with the representatives of other agencies to coordinate plant quarantine enforcement with traffic schedules to expedite the flow of freight cars from Mexico.

Improved highways leading into Mexico from several Mexican Border ports are contributing to a rapid expansion of tourist traffic with that country. Immediately following the lifting of gasoline rationing there was an increase of 600 percent in the volume of tourist traffic over the corresponding period of the preceding year at one port alone, which is indicative of the great increase in this type of traffic that is beginning to mark the postwar era. Tourist automobiles and baggage frequently include fruits, many of which have been found infested with a variety of fruitflies, weevils, plant diseases, and other pests new to the agriculture of this country. There was an increase of eight percent in the total number of inspections of automobiles and other vehicles entering

from Mexico in the first quarter of 1946 as compared with the last quarter of 1945. All of the larger Border ports have airports capable of handling large transport planes, and passenger and air express traffic from Mexico and countries to the South continues to expand. As the airlines add new equipment the rate of expansion accelerates.

Other related work performed in 1945 included the inspection of 5,390 Pullman and passenger coaches arriving from Mexico and 4,749,491 other vehicles. In cooperation with customs, 930,545 pieces of baggage were examined for prohibited plant material. Such pests as the pink bollworm, fruitfly, avocado weevil, and unknown but potentially important coleopterous larvae associated with contraband agricultural material from these sources might easily have been the means of establishing additional plant pests in this country. Furthermore, millions of small lots of fruits and vegetables, purchased in Mexico for local consumption on the American side, were also inspected for plant pests. This required large outlays of inspector-hours, particularly at the larger ports. Among the economically important plant pests prevented from entering were a destructive potato weevil, a bean-pod borer which also attacks alfalfa, the Mexican fruitfly, a lepidopterous larva which is extremely destructive to tomato fruits, and two species of whiteflies which attack subtropical plants.

Ship inspection: The cessation of hostilities, redeployment of troops, return of personnel of the armed forces, return of military and Naval equipment, and the resumption of civil traffic and commerce continue to require maximum efforts to maintain effective plant quarantine protection at the maritime ports of entry. The resumption of civil trade and traffic, together with the needs of the armed forces, is maintaining the demand for plant quarantine protection at an all-time high level for inspection at maritime ports. In 1945 ship arrivals increased 30 percent over 1944, making a total 16 percent greater than the average of the 10 years preceding the war. A total of 35,194 ships were inspected out of 35,555 which arrived. Six thousand and fifty-seven ships were found to be carrying prohibited plant material, all of which is a potential pest carrier. Ship inspections increased over 40 percent from the 8,771 inspected in the last quarter of 1945 to the 12,331 inspected in the first quarter of 1946. Among the pests found in this material were the Mediterranean and Mexican fruitflies, two other species of fruitflies, the West Indian beanpod borer, and a weevil which attacks coconuts. Several serious diseases of fruits and vegetables were collected from the ships' stores. The disposal of garbage likely to present risk of spread of foreign plant pests is likewise a serious problem. The lively and rapidly expanding movement of ships between Hawaii and the Pacific Coast is placing an increasingly heavy demand for plant quarantine protection against pest spread from Hawaii. Such notoricus pests as the Mediterranean fruitfly, the melon fly, the bean-pod borer, the mango weevil, and the pink bollworm of cotton are among those stopped in movement from Hawaii to the mainland by this activity.

Cargo inspection: The fiscal year 1945 was marked by further rapid expansion of wartime commerce, with carriers and cargoes arriving in this country in increasing numbers to meet this Nation's needs for home requirements and its commitments in supplying the great military and naval establishments of the Allies abroad, and in assisting liberated peoples. The gradual substitution of peacetime for wartime commerce characterizes 1946 and continues to place an increasingly heavy demand on existing personnel for plant pest protection at the ports.

During the fiscal year 1945 importations inspected for plant quarantine purposes included in round figures 11,000,000 containers and 5,600,000 pounds of fruits and vegetables, and 57,500,000 bunches of bananas; 426,000 bales, 1,070,000 containers, and 53,700,000 pounds of cotton lint, linters, bagging, cottonseed cake and meal, and other cotton products; 10,700,000 bushels, 635,000 containers, 450,000 pounds of fibres and cereals; as well as large quantities of nursery stock, seeds, and other plant products enterable subject to inspection.

Among the plant materials fumigated or otherwise safeguarded by treatment were 197,000 bales of cotton lint, linters, etc., and 930,000 pounds of cottonseed cake and meal contaminated with uncrushed cottonseed; 1,900,000 units and 5,650 containers of plants, bulbs, roots, and other plant propagating materials on account of infestations of infections by plant pests of economic importance.

Weevil-infested vetch-contaminated straw jackets around wine and liquor bottles arrived during the year in small quantities despite effective steps to correct the situation which is due to conditions arising out of the war. The insects infesting the seeds in the wild vetch are not known to occur in this country and are regarded as a serious potential hazard to the vetch culture of the United States. It was necessary to fumigate 41,000 cases of imported beverages.

A new problem is arising in providing plant quarantine protection for the Uuited States with the return of equipment by the armed Forces, which is fouled with plant litter and other debris capable of bringing injurious plant pests to this country. Liaison has been established with the Army and Navy to study the problem and work out the details of providing adequate protection as occasion arises. The full extent of this problem, in terms of inspector-hours required to meet the emergency, is yet to be determined.

The development of a method of treating citrus and mango fruits to eliminate pest risk has been made available for these fruits if offered for import from Mexico. Where the treatment authorized is applied in the plants that may be approved in the interior of Mexico the approval and supervision of treatment will be by inspectors employed by the Bureau. The transportation and per diem costs incident to approval of the treating plants and supervision of the treatment is to be paid by other agencies on an agreement basis.

3. Certification of exports: The following tabulation records the volume of work for the past two years:

	1944	1945
No. of certificates issued	1,716	2,198
No. of containers certified	594,306	860,696
No. of commodities certified	40	37
No. of countries of destination	58	61
No. of ports of export	29	26

The foregoing tabulation indicates the substantial increases, over 1944, of 22 percent in certificates issued and 45 percent in containers certified. A single certificate may cover a large number of containers with, for example, hundreds of small packets with different kinds of seeds. Inspection of such shipments may require much more time than a large shipment of apples or pears, and is often complicated by the varying requirements of the country of destination for the different kinds of seeds.

During the first quarter of 1946, 1026 certificates were issued to cover 654,082 containers, which is nearly twice the volume for the first quarter of 1945.

(e) Special Research Fund, Department of Agriculture
(Allotment to Bureau of Entomology and Plant Quarantine)

This budget schedule covers obligations under an allotment for special entomological research projects dealing with the subjects "bee products in relation to health" and "investigations of the properties of bee disease organisms and bee products."

(f) White Pine Blister Rust Control, Department of Agriculture
(Bureau of Entomology and Plant Quarantine)

This budget schedule covers obligations under an appropriation (also involving the Forest Service and the Department of the Interior) for leadership, coordination, and technical direction of white pine blister rust control; blister rust quarantine enforcement, and cooperative blister rust control on State and privately owned lands.

(g) Emergency Rubber Project, Department of Agriculture
(Allotment to Bureau of Entomology and Plant Quarantine)

This budget schedule covers obligations during 1945 and 1946 for entomological research and advice on the Emergency Rubber Project. In view of the pending liquidation of the Project, no obligations are contemplated under the allotment in 1947.

(h) Emergency Fund for the President, National Defense (Allotment to Agriculture, Bureau of Entomology and Plant Quarantine)

This budget schedule covers obligations for the fiscal years 1945 and 1946 under a special allotment in connection with the prevention of insect pest infestations.

(i) Working Funds (Bureau of Entomology and Plant Quarantine)

This budget schedule covers obligations under advances, pursuant to Section 601 of the Economy Act of June 30, 1932, for services performed for various agencies as shown in the following statement of obligations under supplemental funds.

STATEMENT OF OBLIGATIONS UNDER SUPPLEMENTAL FUNDS
[1945 and 1946 figures include overtime costs]

	Obligations 1945	Estimated obligations 1946	Estimated obligations 1947
Special Research Fund: Special entomological research	$ 22,039	$ 21,923	$ 21,323
Allotment: Regular item for White Pine Blister Rust Control:			
Leadership, coordination, and technical direction of white pine blister rust control	522,247	588,820	644,200
Blister rust quarantine enforcement	11,815	11,800	11,500
Cooperative blister rust control on State and privately owned lands	299,628	900,943	3,098,411
Total, White Pine blister rust control	833,690	1,501,563	3,754,111
Emergency Rubber project: Entomological research and advice on guayule rubber	9,314	5,000	- -
Emergency fund for the President, National defense: Emergency insect pest prevention	257,227	3,000	- -
Working Funds (Bureau of Entomology and Plant Quarantine) Advances from:			
Office of Scientific Research and Development: For investigations on methods of control for insects affecting the armed forces	422,914	182,732	- -
War Department: Army Air Forces, for control of the dog fly along Fla. Gulf Coast in vicinity of air training stations	135,886	106,440	- -

	Obligations 1945	Estimated obligations 1946	Estimated obligations 1947
Working Funds (Bureau of Entomology and Plant Quarantine) Advances from (cont'd)			
Commodity Credit Corporation:			
For the conduct of investigations of methods of properly caring for grain in storage..	3,500	2,836	- -
Total, Working funds	562,300	292,008	- -
Total, Obligations under Supplemental Funds	$1,684,570	$1,823,494	$3,775,434

(Continued on next page)

(j) Control of Emergency Outbreaks of Insects and Plant Diseases

Appropriation Act, 1946		$2,700,000
Budget estimate, 1947		2,800,000
Change for 1947:		
Overtime decrease	-43,000	
Increase to maintain appropriation at approximate annual average amount of past appropriations, plus increased costs due to Federal Employees Pay Act of 1945	+143,000	+100,000

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)
1. White fringed beetle control	$680,749	$771,000	- -
2. Pear psylla control	407,956	431,000	- -
3. Hall scale eradication	34,115	55,000	- -
4. Grasshopper and Mormon cricket control	944,085	617,000	- -
5. Armyworm control	- -	15,000	- -
6. Chinch bug control	404,403	50,000	- -
7. Mole cricket control	44,457	57,000	- -
8. General surveys	159,703	153,000	- -
9. Overtime pay	226,858	43,000	- -
Reserve for future allotment	- -	508,000	- -
Covered into Treasury as miscellaneous receipts, Public Law 529	1,000	- -	- -
Unobligated balance	876,724	- -	- -
Total estimate or appropriation.	3,780,050	2,700,000	2,800,000(1)

(1) It is not practicable to indicate with satisfactory accuracy a year in advance the amounts which may be required for specific projects, since the amounts to be allotted depend largely upon factors, including weather, that cannot be predicted.

WORK UNDER THIS APPROPRIATION

This appropriation was included for the first time on a regular fiscal year basis in the annual Appropriation Act for the fiscal year 1945 and has since continued on that basis. For practical operating purposes, however, work done under this appropriation is conducted on a crop season basis, and the following paragraphs will summarize briefly the activities for the past season, including certain information with reference to work under way at the present time.

Following is a list of the appropriations which have been made for Emergency Outbreaks of Insects and Plant Diseases since the program was first authorized by Public Resolution No. 20, approved April 6, 1937:

Reference to Act	Amount
Public Resolution No. 26, approved April 27, 1937	$1,000,000
Public Resolution No. 55, approved July 17, 1937	1,000,000
Public Resolution No. 81, approved March 2, 1938	2,000,000
Second Deficiency Appropriation Act, 1938	700,000
First Deficiency Appropriation Act, 1939	3,000,000
Public Resolution No. 22, approved June 13, 1939	1,750,000
First Deficiency Appropriation Act, 1940	2,500,000
Second Deficiency Appropriation Act, 1940	800,000
First Deficiency Appropriation Act, 1941	2,225,000
Sixth Supplemental National Defense Appropriation Act, 1942	1,750,000
First Deficiency Appropriation Act, 1943	3,722,000
Department of Agriculture Appropriation Act, 1945	2,700,000
Public Law No. 26, approved March 31, 1945	1,080,050
Department of Agriculture Appropriation Act, 1946	2,700,000*

*Available to June 30, 1946; however, it may be necessary to request a supplemental appropriation to provide for an anticipated increase in operations from the beginning of the 1946 field season until July 1, 1946.

A substantial part of the funds provided by these several appropriations in the past have been used to enable the Department to cooperate with States in combating widespread outbreaks of grasshoppers, and to take active large-scale control measures against the Chinch bug, the white-fringed beetle, the Mormon cricket, and the pear psylla. Work has been done from year to year against other pests reaching outbreak numbers and threatening extensive crop damage or spread to new areas.

Operations against the white-fringed beetle, the pear psylla and the Hall scale have developed a pattern and work plan which has not changed fundamentally during the past three years. The accomplishments of the past year, and the current program, are discussed in the following paragraphs.

Progress and Current Program:

White-fringed beetle control: Scouting and delimiting inspections for the White -fringed bettle were made between and beyond infested areas during the year to locate any new infestations of the beetles that might exist, 31,526 man-hours being devoted to the work. Some 14,411 acres of infestations not previously known to exist, were found making a total of 140,000 infested acres in the States of Alabama, Florida, Louisiana, Mississippi and North Carolina.

Effective insecticidal control was applied to reduce populations of the beetles around trade centers, railroad yards, amusement centers, and warehouses and processing plants, from which there is greatest hazard of spread. Wherever appreciable infestations existed in cotton, peanuts, or other crops, the marketing of which might present a hazard of spread, control measures were applied to the extent necessary to alleviate this hazard.

During the year approximately 1,000,000 pounds of insecticides were applied to an aggregate of 68,702 acres. The insecticides were applied with dusters, dilute sprayers, and concentrated sprayers. The results obtained showed marked improvement over previous years.

Extensive field tests were conducted, comparing DDT with cryolite and calcium arsenate. The materials were applied as dusts, dilute sprays, and concentrated sprays. Almost without exception better results were obtained where DDT was applied following procedures outlined by research workers.

To cope with manpower shortages and effect economies, new devices were developed for application of insecticides. Tractor mounted combination spray and dust machines requiring much less labor to treat increased acreage are in effective use in numbers.

In cooperation with state agricultural agencies, cultural crop practices were recommended whereby heavily infested portions of farms could produce profitable winter crops such as oats and legumes during the season when crop damage is least. This procedure permits of cultivation by farmers for control of beetles during the active beetle season. During the 1944-45 winter nearly 2,000 acres of such winter crops were produced.

Especial effort was extended in all areas to cooperative work with producers and shippers of white-fringed bettle host commodities to devise and implement sanitation practices by which their products could safely move to market with least inconvenience to them.

Pear psylla control: The area found infested by the pear psylla in the Pacific Northwest in 1944 was essentially the same as in previous years, except for some northward extension in the commercial area of British Columbia. 403 infestations were found as compared to only 140 in 1943. This is believed to be not an actual increase, but

rather a larger finding resulting from a marked increase in the efficiency in survey methods. Also of importance was the fact that more than three-fourths of the 1944 infestations were in Washington counties having practically no commercial acreage (Columbis, Garfield, Stevens, and Whitman), and were on dooryard or home orchard trees. The area known to be infested was extended in the spring of 1945 when several infestations, all on non-commercial properties, were found for the first time in Klickitat County, Washington.

Most of the survey work was carried on by the use of the sticky board pear psylla trap. These traps have repeatedly revealed infestations so light that their detection by visual scouting would have been very unlikely. A further improvement for scouting has been the use of sticky paper bands placed on the trunk and larger branches during the dormant period. Bands placed on trees in the Entiat Valley in November 1944, removed early in the spring, and examined as opportunity offered, brought to light a number of infestations in that area.

The program of spraying against the pear psylla has been continued, with some modifications. For the most part, the dormant spray was supplanted with three applications during the summer against the nymphs, or immature psyllas, on a 15-day schedule. As previously the sprays were applied to all commercial plantings by the growers themselves, with material furnished by the Bureau. Non-commercial plantings were sprayed with Bureau equipment. This program appears to have been effective in preventing spread and many isolated infestations have been eliminated. Canadian officials and growers actively cooperated in a suppression program in British Columbia during 1945.

The program of grubbing and treating stumps and regrowth has been continued, by both Bureau and state crews. Ammonium sulfamate has been used for the treatment of regrowth. The elimination of pear growth and stumps has added greatly to the efficiency of the program as a whole by eliminating the necessity for repeated visits to these properties.

Hall scale control: Efforts to eradicate the Hall scale have been continued, in cooperation with the California State Department of Agriculture. Although intensive survey and inspection brought to light a few more infested trees during 1944, the area known to be infested by this insect remains approximately the same as previously, and all infestations are still limited to the U. S. Plant Introduction Garden and a small number of orchards within 5 or 6 miles of Chico. Inspections have also been made, without revealing any infestations, of host plants sent from the U. S. Plant Introduction Garden to certain communities in several California counties prior to 1934 (subsequent to this date all stock has been fumigated before shipment).

Two applications of oil spray were made in 1944 to all infested trees and to trees in their general vicinity, and three applications were made to trees known to be severely infested. As a result of these applications and others in previous years, the scale population has declined

and, apparently, there has been practically no apread. However, since some of the scales settle in protected places where sprays do not reach them, it is now concluded that eradication by any known method of spraying would be a long, slow process and perhaps impossible.

Tests carried on with HCN fumigation in 1944 under specially treated tents gave practically 100 percent kills of scale with gas concentrations that have not injured a variety of host plants during the dormant period. Consequently, it is believed that eradication is possible through HCN fumigation, or through fumigation supplemented by the use of oil sprays. Accordingly, the control program has been revised to include the fumigation of infested trees, together with trees nearby that might carry infestations too light for ready detection, with heavy doses of cyanide.

The other programs conducted under this appropriation are much more subject to variation from year to year than the three discussed above. The following paragraphs summarize recent developments in connection with them.

Grasshopper and Mormon Cricket Control: Work against grasshoppers has been conducted for a number of years in cooperation with practically all the States west of the Mississippi River. Surveys made in the fall of 1944 indicated that during the 1945 field season there would be grasshopper outbreaks of threatening to severe intensity in a few counties in Arizona and California and over somewhat broader areas in the Plains States, notably the Dakotas and eastern Montana. In general, the oubreaks occurred rather closely in line with the indications of the survey and were dealt with through the usual Federal, State, grower cooperative efforts. In addition to making bait materials available through designated State and county agencies for distribution to farmers for crop protection purposes, the 1945 program included cooperative roadside and idle land baiting on a county-wide scale in areas where conditions were such that extensive migrations might have developed. This permitted more effective control with a minimum expenditure of labor and materials.

Mormon cricket infestations developed this year very much as indicated by the egg surveys made in the fall of 1944. The more extensivd outbreaks occurred in Idaho and Nevada and control operations were conducted in these States, also in Oregon and in limited areas in California, Colorado and Wyoming.

Chinch Bug Control: Early this year broad areas in the Middle West appeared to be threatened by the most severe chinch bug outbreak since 1934. This condition led to the appropriation by Congress of supplemental funds in the amount of $1,080,050. Fortunately unfavorable weather conditions kept the infestation below the proportions which had been feared and it has been effectively dealt with through the use of the usual barrier materials. Rather extensive purchases of these materials had been made in anticipation of a severe outbreak, but the amounts not used have been stock-piled at strategic points for use in the future. These materials are not subject to rapid deterioration.

Mole Cricket Control: In cooperation with the Florida State Mole Cricket Control Committee, the State Plant Board and the county governing boards, the Bureau, again in 1944 assisted farmers with the control of mole crickets in 13 counties in the State of Florida. Following a cooperative survey to determine bait requirements a program was carried out on the same basis as in previous years, in that the Bureau assumed the responsibility for purchasing, delivering, mixing, sacking and labeling the bait used in connection with the program, and the state cooperating agencies assumed the responsibility for distributing the bait to the farmers who used it under the direction of such agencies. The county governing boards agreed to assume all liability arising from baiting. A total of 562 tons of bran and ground wheat, and 48 tons of sodium fluosilicate was used in the work during the season. It was the consensus of the farmers on whose premises the control work was conducted, that the bait was satisfactory and that mole cricket population had been reduced on the baited land to the extent that crops were permitted to develop normally. This would not have been possible otherwise because of the nature of damage by mole crickets which made numerous runways just beneath the surface of the soil injuring the roots of seedling plants in addition to actually feeding on plant roots or the lower part of the stem.

General surveys: For several years funds provided under this appropriation have been used to carry on surveys to secure information on the abundance and the threat to crop production of certain important crop pests, including insects attacking cotton, the Mexican bean beetle, pea aphid, cabbage worms, and other pests of truck crops, the screwworm and other insects requiring the use of insecticides. The information thus secured which has been placed at the disposal of cooperating agencies and manufacturers and distributors of insecticides, has facilitated the most effective use of insecticides, many of which are severely limited by war conditions. It has also enabled the farmers to plan in advance their operations against insect pests. These operations are being continued during the 1945 crop season.

Surveys also have been conducted to secure information on pests of limited distribution and those subject to state quarantines. These surveys have dealt with the oriental fruit moth on which information was particularly needed to determine sound quarantine practices for certain Western states, and the golden nematode of potato, which is now under quarantine in New York State and which would be capable of doing wide-spread damage in many parts of the country should it become widely distributed. The 1944 surveys for golden nematode carried on in 19 states disclosed no infestation except on Long Island.

PASSENGER-CARRYING VEHICLES AND AIRCRAFT

Passenger-Vehicles

Salaries and Expenses: Prior to the current fiscal year the Bureau of Entomology and Plant Quarantine had not purchased any passenger cars since 1943. It is proposed to purchase 45 in 1947, 43 of which will be replacements.

Of the two additional vehicles, one is to be at Beltsville, Maryland on the Insecticide and Fungicide project, and one additional car is for use on the Forest Insects project at New Orleans, Louisiana and adjacent southern States to make field inspection trips. At present there is no passenger-car located at this point.

Control of Emergency Outbreaks of Insects and Plant Diseases: Eight additional cars are required on this project. Prior to the current fiscal year, no passenger-carrying cars have been purchased for projects under the appropriation for Control of Emergency Outbreaks of Insects and Plant Diseases. A limited number will be purchased this year.

Four of the additional cars are needed by supervisors for control operations throughout the White Fringed Beetle Control area, three being headquartered at Gulfport, Mississippi and one at Wilmington, North Carolina.

Four additional cars are needed in the Pear Psylla Control area of Washington, Oregon and Idaho at locations where there is no public transportation. These cars will be headquartered at Spokane, Washington.

Airplanes

Salaries and Expenses: Inquiries with reference to the use of aircraft for insect control work have increased many fold during the past year. This interest is due primarily to (a) the extent to which planes were used during the war for the control of mosquitoes and other disease-carrying insects in and around army camps, (b) the many army and navy trained pilots who desire to continue flying as a civilian occupation, (c) the recent development of new insecticides that may be successfully applied from aircraft as dusts or highly concentrated sprays, and (d) the extent to which farmers are adopting this method of protecting their crops.

In order to be more adequately prepared to answer questions with reference to the advantages and limitations associated with the use of aircraft for the distribution of insecticides, it is planned to purchase two planes for work of an experimental and developmental nature.

The five planes proposed to be acquired for Insect and Plant Disease Control work will be used to intensify federal-state cooperative effort to eradicate or suppress the gypsy moth in the New England states and in connection with Japanese beetle control work in infested areas. It has been demonstrated experimentally that the use of aircraft will greatly facilitate field operations in connection with these projects.

Control of Emergency Outbreaks of Insects and Plant Diseases: The three planes which it is proposed to purchase for control of emergency outbreaks of insects and plant diseases will be used to replace similiar equipment which has been used on projects financed with these funds but which are no longer serviceable and have already or soon will be salvaged. This equipment is used principally in connection with the grasshopper, Mormon cricket, and white-fringed beetle control programs.

No additional language authority is necessary in connection with any of these proposed purchases.

PENALTY MAIL ESTIMATE
Sec. 2, Public Law 364, 78th Congress
(Allotment to Bureau of Entomology and Plant Quarantine)

	1945	1946	1947	Increase (+) or Decrease (-) 1947 over 1946
Category 1	$1,070	$1,400	$1,700	+300
Category 2	10,188	11,800	13,300	+1,500
Total	11,258	13,200	15,000	+1,800

Category 1 consists of leaflets, bulletins and other technical publications issued as a result of research work on entomology and mailed in answer to specific requests for information and for partial reply to inquiries regarding the programs of the Bureau.

The increase of $300 will be needed to defray the additional cost of mailings of leaflets and technical publications requested by the public and organizations especially interested in the work of the Bureau - such as leaflets on DDT, household insects, and the gardener's handbook on insects and diseases. As the funds expended for research are increased results are obtained which are made available to the public.

Category 2 consists of general administrative correspondence between the field stations of the Bureau and Washington, and with State Departments of Agriculture, State colleges, and experiment stations cooperating with the bureau in its programs. There is also included correspondence in connection with requests for information on the identification of insects and for advice on control programs such as Japanese beetle control, pink bollworm and Thurberia weevil, sweetpotato weevil, white pine blister rust control and many others.

The increase of $1,500 is to take care of administrative mailings as a result of the increased activity in the programs work. While the total funds of the Bureau show an increase of 28% over 1946 it is felt that the administrative mailings will increase approximately 13%, as some items included in the increases will not add substantially to the mailings.

BUREAU OF AGRICULTURAL AND INDUSTRIAL CHEMISTRY

(a) Salaries and Expenses - Preamble

CHANGE IN LANGUAGE

The estimates include a proposed change in the language of the appropriation preamble, as follows (new language underscored, deleted matter enclosed with brackets):

> For investigations, experiments, and demonstrations hereinafter authorized, [independently or in cooperation with other branches of the Department, other departments or agencies of the Federal Government, States, State agricultural experiment stations, universities, and other State agencies and institutions, counties, municipalities, business, farm, or other organizations and corporations, individuals, associations, and scientific societies,] including the employment of necessary persons and means in the City of Washington and elsewhere, of which not to exceed [$176,528] $247,966 may be expended for personal services in the District of Columbia, as follows:

The proposed change in language deletes certain provisions relating to cooperation in effectuating the purposes for which the appropriation is made. The sole purpose of the proposed deletion is to shorten and simplify the item. The clauses proposed for deletion are considered surplusage and, therefore, need not be retained in the annual appropriation act, the cooperative work being authorized by the Act of May 15, 1862 (5 U.S.C. 511), establishing the Department of Agriculture, as implemented by the Act of July 24, 1919 (5 U.S.C. 563-564). Elimination of the language from the annual appropriation act will not--in any way--change the scope or character of the work performed under this appropriation, or the authority of the Department to cooperate with other agencies, institutions, organizations, or others in the conduct of such work.

(b) Agricultural Chemical Investigations

Appropriation Act, 1946		$350,000
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+44,000
Total anticipated available, 1946		394,000
Budget estimate, 1947		576,000
Change for 1947:		
Overtime decrease	-5,300	
Increase	+187,300	
		+182,000

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Fruits, vegetables, and other agricultural products of the South ..	$67,509	$102,737	$103,000	+$263 (1)
2. Sugars and sirups investigations	67,222	83,528	83,700	+172 (1)
3. Investigations on pharmacology of agricultural products	23,899	32,641	57,500	+24,859 (2)
4. Investigations on enzymes and phytochemistry	26,872	35,550	67,700	+32,150 (3)
5. Fruits, vegetables, and other agricultural products of the West ...	33,819	50,849	66,000	+15,151 (4)
6. Fundamental investigations in microbiology of agricultural products ..	33,930	40,449	40,500	+51 (1)
7. Tung nuts investigations	24,720	30,813	30,900	+87 (1)
8. Basic investigations in the chemistry of agricultural products ..	8,228	12,133	67,000	+54,867 (5)
9. Investigations on chemical methods of isolation and identification of substances of agricultural origin responsible for allergic reaction ..	- -	- -	59,700	+59,700 (6)
10. Overtime pay	42,870	5,300	- -	-5,300
Covered into Treasury as miscellaneous receipts, Public Law 529	106	- -	- -	- -
Unobligated balance	45,731	- -	- -	- -
Total available	374,906	394,000	576,000	+182,000
Transferred to "Salaries and expenses, Office of Information"	+195	- -	- -	
Anticipated supplemental ...	- -	-44,000	- -	
Total estimate or appropriation (1945 adjusted for comparability)	375,101	350,000	576,000	

INCREASES OR DECREASES

The net increase of $182,000 in this item for 1947 consists of the $5,300 decrease for overtime, and the following:

(1) Increases totaling $573 under projects 1, 2, 6, and 7, for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(2) A total increase of $24,859 under Project 3, composed of:

(a) An increase of $24,800 to permit adequate investigation of pharmacological and toxicological problems arising in the research work of the Bureau:

The Problem and its Significance: The four Regional Research Laboratories are developing new chemical compounds such as insecticides, antioxidants, antibiotics, and byproducts from procedures such as the continuous saccharification process. They are also developing products such as starch sponges, artificial suture materials, gluten sulfate, and rutin. Since the use of these compounds and materials may give rise to public health problems in some instances, while in other cases valuable medicinal uses may depend upon useful pharmacological properties, investigations of acute and chronic toxicities and general pharmacological actions are necessary.

The value of new insecticides such as nicotine derivaties for use on fruits and vegetables must ultimately depend upon the proven absence of a public health hazard traceable to spray residues. This means that all such proposed compounds must be investigated pharmacologically to determine whether or not the repeated ingestion, over long periods of time, of amounts likely to occur in spray residues may lead to symptoms of toxicity. Similarly, the value of organic antioxidants to be used for the preservation of, or the prevention of rancidity in, foods must be dependent upon the demonstrated absence of acute and chronic toxicity. The use of antibiotics, gluten sulfate, rutin, etc., for medicinal purposes, and the use of starch sponges and artificial suture materials in surgical procedures must be based upon an understanding of pharmacological properties and a reasonable lack of toxicity.

(b) An increase of $59 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(3) A total increase of $32,150 under Project 4, composed of:

(a) An increase of $32,100 to permit increased activities in developing fundamental information on the characterization and functions of enzymes of agricultural materials, and apply such knowledge to the processing and preservation of foods:

The Problem and its Significance: In the processing of agricultural materials to produce foods and feeds, as well as in the handling and storage, there are many changes in physical and chemical properties affecting acceptability of the final products. Many of these changes are known to be due to enzymic action. To devise processing, handling and storage procedures which result in a minimum of deterioration of the product, the functions of the enzymes present in the raw materials and their behavior during processing and storage must be studied and methods devised to control their activity.

The palatability, nutritional value, and general acceptability of foods are of great importance. Deterioration during processing, handling or storage may be in small degree, reducing the nutritional value or making the food slightly less acceptable to taste, or in appearance, or it may be to an extent to render the food unfit for human consumption. The loss is but one of degree. Any information which will eliminate or even reduce this deterioration will contribute to human welfare. Knowledge of the part that enzymes take in these changes may indicate preventive or corrective measures.

(b) An increase of $50 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(4) A total increase of $15,151 under Project 5 composed of:

(a) An increase of $15,000 to develop information and intensify studies on processed citrus fruits and on the preservation and processing of soft fruits:

Objective: To increase income to growers of citrus and soft fruits by developing new and improved processes and products derivable from such fruits, thereby creating new and expanded markets; to determine causes of deterioration of processed fruits and devise methods to prevent or reduce such deterioration.

The Problem and its Significance: The increase in production of citrus fruits, the changes in buying habits of the consumer of these fruits, and the unacceptability of some of the citrus products now on the market have caused an urge by the citrus industry that the work on citrus fruits be accelerated. Certain varieties of citrus fruits of Arizona and California do not yield satisfactory canned juices or segments. The volume of production of these fruits is of such importance that intensified studies on the causes of such failure is needed. Certain of the soft fruits of the Northwest will require special processing technique in order to yield products acceptable to other than the fresh fruit market. There is a need also for developing products for berries which are sound, but too ripe to be shipped for the fresh fruit market. Technique of various types of processing applicable to a wide variety of fruits must be developed.

General Plan: Studies on the processing of citrus fruits of Arizona and California would be carried on at the U.S. Fruit and Vegetable Chemistry Laboratory at Los Angeles, in cooperation with the citrus industry of that region and other agenices of the Agricultural Research Administration. The work on soft fruits and berries would be carried on at the Fruit and Vegetable Byproducts Laboratory at Pullman with the fruit industry growers and processors of that area and with other agencies of the Agricultural Research Administration.

(b) An increase of $151 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(5) A total increase of $54,867 under Project 8 composed of:

(a) An increase of $54,800 to investigate (1) the biochemical factors responsible for plant disease resistance and (2) the synthesis and mechanism of action of natural and synthetic plant hormones:

Objectives: (1) To investigate economically important plants, particularly tomatoes, peas and cabbage for the presence of biochemical substances that may be responsible for the resistance of certain varieties of these plants to specific diseases; to isolate and identify these substances; in cooperation with the Bureau of Plant Industry, Soils and Agricultural Engineering to apply the information gained in the prevention or control of these plant diseases and as aids in the breeding of more resistant plant varieties; to test the specificity of the antibiotic agents found toward human, animal and plant pathogens.

(2) To prepare new synthetic plant hormones and modifications of naturally occurring ones; to test these compounds, in collaboration with the Bureau of Plant Industry, Soils and Agricultural Engineering for selectivity and potency of action in producing growth modification in plants; to determine the chemical groups responsible for plant hormonal action; to determine for selected hormones the mode of entry and method of transport within the plant, the mechanism of their action and the biochemical changes elicited by their introduction into the plant.

The Problem: (1) Many economically important plants are subject to diseases caused by specific micro-organisms such as the bacteria, fungi, and viruses. In many cases varieties of a given plant are known that are highly resistant to certain plant pathogens while other varieties of the same plant exist that are highly susceptible to attack and damage by these organisms. The growing plant elaborates a wide variety of biologically active chemical compounds yet little is known concerning the nature of many of these substances or of the role which each plays in the economy of the plant. Among the most interesting of the biologically active compounds elaborated by the growing plant are certain antibacterial and antifungal principles,

recently shown to be present, whose ability to inhibit the growth of microorganisms is similar to that exhibited by such well-known antibiotics as penicillin and streptomycin. It is possible, therefore, that certain plants may elaborate specific chemical compounds that are effective against the organisms that cause certain diseases and that the ability of a given plant variety to resist the attack of the pathogen may depend upon its ability to produce the antibiotic agent in sufficient quantity or at a sufficiently rapid rate. The presence of an antibiotic agent that is effective against the fungus which causes Fusarium wilt in tomatoes has been demonstrated. The present problem involves the extension of these investigations to other plants and other diseases and the detailed study of the antibiotic agents found in accordance with the objectives set forth above.

(2) The application of organic chemical compounds to plants for the purpose of producing modifications in the rate and character of growth is being widely practiced experimentally and, in some cases, practical application of the results of these investigations has been made. Among the hormonal effects exhibited by the chemical compounds so far investigated are stimulation of root formation and growth, prevention of abscission and fruit drop, artificial fertilization and stimulation of maturation in fruits and vegetables, bud inhibition and the development of dormancy in stored seeds and vegetables, increase in the sugar content of attached or detached fruits, and selective weed and pest plant eradication. While the over-all effects of plant hormones are apparent, practically nothing is known concerning the mechanism by which the effects are accomplished or of the biochemical changes within the plant that are brought about by the application of infinitesimal amounts of active chemical compounds and since larger amounts cannot be used without danger of causing injury to the plant, the problem of investigating the mechanism of action of these hormones will require the development of ultramicro techniques for the detection of the hormone in the plant and for following the biochemical changes which ensue. Success in such investigations will aid in determining the chemical structures that are responsible for hormonal action and will thereby make it possible to synthesize new compounds which may have more specific and desirable hormonal effects.

Significance: (1) Plant disease annually causes heavy losses to the farmer. The severity of losses due to disease in fruit, vegetable, and cereal crops is dependent upon many factors but under most conditions serious inroads into the size of the marketable crop can result from the attack of one or more of the bacterial, fungal, or virus pathogens. Intensive efforts have been, and continue to be, made to develop varieties of economically important plants that are resistnat to specific plant diseases in order to minimize the effects of these diseases on crop yields. As a result of the efforts of plant breeders over many years, many resistant plant varieties have been developed but little or nothing is known concerning the biochemical factors that are responsible for disease resistance in the varieties that have been discovered by these painstaking and time-consuming breeding and selection experiments. Should it prove possible to isolate from plant tissue chemical compounds which

possess antibiotic activity toward specific plant pathogens a whole new approach would be opened to the important problem of the prevention and control of plant disease. If it can be demonstrated that disease resistance in plants is due to the presence of specific, identifiable chemical compounds, one of the most important obstacles that has hitherto prevented a systematic attack on the plant disease problem, namely, the lack of adequate physical and chemical information and techniques, will be eliminated. The successful outcome of the proposed investigations may permit the use of chemical methods as aids in plant breeding and may, by facilitating the improvement of cultural methods fer increasing the production of specific antibiotics in the growing plant, lead to the rapid development of effective precedures for preventing or controlling plant disease.

(2) While the wide scale application of plant hormones and weed killers to greenhouse and truck creps is relatively new, the use of plant hormones gives indications of becoming as important agriculturally as the use of fertilizers, fungicides, and insecticides. This nation's effect and ability to produce more and better food crops for itself and for peoples abroad in this important period of post-war rehabilitation will be influenced greatly by the progress of basic and applied research in the phytohormone field.

For a plant hormone to be used on a wide scale, it is necessary that it be capable of production in large quantities and at a reasonable price. Both of these requirements have been met in the discovery and use of the phenoxyacetic acid derivatives. Of these compounds, 2,4 dichlorophenoxyacetic acid and the corresponding 2,3,5 trichloro-acid are enjoying popularity at the present time because of their unique ability to act as plant stimulators in low concentrations and as selective weed killers in higher concentrations. While the growth stimulatory and modifying properties of these two compounds have been known for some time it was not until within the last year that the selective phytocidal properties of the 2,4 dichlorophenoxyacetic acid has been found useful in hastening the ripening of peas, apples, and bananas. The period required for ripening can be shortened in some cases by as much as two weeks. This same compound can also be used for the artificial fertilization of tomatoes in the production ef parthenocarpic (seedless) fruit. Applied as a weed killer in higher concentrations, 2,4 dichlorophenoxyacetic acid has been found to kill dandelion, narrow-leaf plantain, Dutch white clover, chickweed, pigweed, wood sorrel, knotweed, broad-leaf dock, bindweed, and shiny pennywort without injuring Kentucky bluegrass sod.

Plant hormones have also been used to prevent abscission and the resultant early drop of fruits, particularly apples. This use has resulted in a substantial saving to apple growers whose annual losses due to early fruit drop are large. Hormones have been used to prevent budding or shooting of potatees during storage, thereby reducing losses. The problem of plant propagation from rootings or cuttings in plants that do not normally grow or grow very slowly in certain

seasons, or that do not grow from seeds, has been successfully solved by the use of plant hormones. An important example of the use of hormones for this purpose occurred during World War II. The insecticide-producing Derris plant was successfully propagated from leaf cuttings after the supply of this plant had been cut off by the Japanese occupation of the Dutch East Indies.

Plan of Work: (1) At least two laboratories must be equipped with the specialized apparatus and staffed with the highly-trained personnel required to conduct investigations involving the detection, determination (assay), isolation, and identification of biologically active chemical compounds (antibiotic agents) present in growing plants. Investigations would be conducted to ascertain the mechanism of action in the plant and the specificity of each of the antibiotic agents isolated. In cooperation with geneticists, physiologists, and patholigists of the Bureau of Plant Industry, Soils and Agricultural Engineering, experiments would be devised and conducted to test the feasibility of applying any antibiotic agents isolated or any biochemical information obtained in the course of these investigations, in the control or prevention of specific plant diseases and as aids in plant breeding experiments.

(2) At least two laboratories must be equipped and staffed for plant hormone research. One of the laboratories must be equipped for micro and semi-micro quantitative organic analysis in order to determine the identity of newly isolated, naturally occurring plant constituents and for the determination of the purity of synthesized plant hormones. It would be desirable to have this laboratory equipped for temperature and humidity control. The second laboratory must be equipped for physical chemical work, including electronic apparatus for the detection of radio-active elements. Preliminary investigations would be conducted to select a compound (or compounds) which is representative of a well-established class of plant hormones but which has a relatively simple structure and contains, if possible, the minimum number of functional groups necessary for hormonal activity. For the purpose of investigating the mechanism of hormonal action the compound selected would be synthesized so as to contain certain radio-active elements.

When compounds containing radio-active elements are introduced into the plant their progress and fate can be followed by testing plant parts and extracts for radio-activity by means of electronic detection equipment. In this manner, by the use of "tagged" or "labeled" hormones, the method of transport and the time required for the transport of a given hormone within the plant can be determined and the ultimate disposition of the hormone by the plant can be ascertained.

(b) An increase of $67 for placing on a full year basis in 1947, within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

(6) An increase of $59,700 under Project 9 to conduct research investigations on chemical methods of isolation and identification of substances of agricultural origins responsible for allergic reactions:

Objective: This project proposes establishment of a new field of chemical research - the investigation of the chemical basis of immune reactions - directed primarily to the identification of the chemical components involved in development or loss of immunity to disease, and the characterization of immune substances - antigens, antibodies, allergens - with respect to their chemical composition, chemical properties, and related specific biological activity.

The Problem: Immune reactions are biological processes by which the living animal develops defensive agents against overwhelming invasion by disease-producing microorganisms. The defensive agents are antibodies. Development of antibodies in the tissues of the animal results from reaction of these tissues with certain products of microbial invaders called antigens.

Antigens and antibodies are both products of living organisms; both are generally comprised of highly complex protein substance. Antigens and antibodies react with each other and when the quantities of each are suitably proportioned the result is neutralization and disappearance of the biological activity of each. The natural site of immunological reactions is within the tissues of the living animal and follows invasion of these tissues by living microorganisms. Thus, depending on viewpoint, an immunological reaction may be regarded as biological - the physiological response of the living animal to infection by a disease-producing germ, or, as an essentially chemical reaction. In the latter sense, the living animal responds to bacterial infection by producing antibody, which for the animal is an entirely new chemical component of its tissues - and one that was not previously present or needed. Antigen, on the other hand, is a natural product of certain disease-producing organisms; it is likewise a protein substance and exhibits specific chemical activity. Antigen serves the invading organism as a chemical agent of attack to destroy the defensive resistance of the host.

The importance of biological aspects of immunological reactions is firmly established in relation to both veterinary and human medicine. Systematic analysis of the opposing life processes - infection versus resistance - has led to measurable advances in effective control of many diseases and virtual eradication of some most feared in previous generations. Dependent on immunological reactions are prevention of epidemic diseases by establishing immunity with vaccines and serums, diagnosis of diseases by serological and cutaneous reactions; and the treatment of active disease with antitoxins. Less understood and less appreciated is the fact the biological studies of immunological reactions has revealed information of both theoretical and practical importance concerning the chemical nature of proteins.

These contributions have been utilized in several ways. They permit certain identification of proteins that cannot be distinguished by other analytical methods. Serological techniques provide micro-analytical methods by which a minute amount of a particular protein can be detected even when concealed by large amounts of similar proteins or in mixtures of great complexity. Practically employed, this means that the proteins of blood, meat or seeds, though dried, ground and mixed beyond recognition by any other means, can be identified with respect to the particular species of animal or plant from which each component was derived. Immunological researches directed to practical control of disease led incidentally to discovery of several proteins which at first appeared to be merely new and unique members of this chemical category. Emerging from the transition of immunological to chemical studies of these proteins have come the identification of the virus of tobacco mosaic disease, the isolation and use of several fractions of blood plasma for specific needs in transfusion, and treatment of battle wounds.

Significance: Immunological reactions comprise the foundation of the most effective measures yet conceived for prevention, control, and ultimate eradication of infectious diseases of livestock. In general, these reactions are characterized by a high degree of specificity. But this is not absolute. Consequently, diagnostic conclusions and immunizing procedures that are based on immunological reactions are not of unfailing reliability. Attainment of perfection or even substantial improvement in any one of the more important of these disease-control measures would yield impressive returns. One example may be cited: This one is selected because reliable data are available. Some cattle that react to the tuberculin test do not on post-mortem examination show visible lesions of tuberculosis. Inoculation tests made in recent years have demonstrated that some of the cattle which do not show such lesions on post-mortem examination actually are affected with the disease in its early stages. There also seems to be little doubt but that in some cases reactions are caused by organisms other than true tubercle bacilli. The benefits from slaughter of cattle reacting to the tuberculin test are far-reaching and the number which showed no lesions of tuberculosis on post-mortem examination is extremely small. On the other hand, the total value of such animals is large in comparison with the proposed expenditure for this project. While the present tuberculin test is highly accurate, any improvement which will minimize the chance of an animal reacting when it is not affected with tuberculosis will, in addition to the savings in State and Federal expenditures for indemnity payments, increase the confidence of cattle owners in the test. It is reasonable to predict that investigations outlined in the following plan of work would yield profitable returns if applied to the tuberculin reaction. Many other immunological reactions pertaining to control of animal diseases present like problems for solution.

To define the limits of investigations contemplated under this project, it is presumed that immunological reactions are essentially chemical reactions involving separable and distinguishable chemical entities.

WORK UNDER THIS APPROPRIATION

Objective: (1) To increase farm income by solving problems which cause loss of value of crops or which interfere with their consumption along established lines; (2) to develop new forms of certain agricultural crops to more satisfactorily meet consumer requirements; (3) to devise means of improving the initial and storage quality of processed agricultural commodities; (4) to reduce handling and processing costs; (5) to develop uses for agricultural byproducts and wastes, and to devise methods of processing of agricultural materials for feed purposes; (6) to render technical assistance to farmers' cooperative processor organizations; (7) and to assist in developing "deficiency" crops (e. g. tung nuts) for supplying products for which existing supplies are inadequate.

The Problem and its Significance: Our armed forces and Lend-lease absorbed the greatly increased production of food during the war, and during that time we developed better methods of processing and handling a wide range of food products and created replacements and supplements to formerly imported products from agricultural products. Since the end of the war, there has been a decrease in demand for the needs of the military forces and it is expected there will be an increased availability of foreign-produced commodities. This will make it necessary to emphasize investigations under this appropriation item to develop basic and applied research datafor peacetime use, which will be urgently needed in such industries, for example, as the citrus industry, which has been processing a substantial portion of the citrus crops for juices, concentrates, marmalades and similar materials for Lend-lease and military service requirements. Similar type of research will be needed to take care of the problems arising for fruits other than citrus, vegetables, tung nuts, etc.

To accomplish this, investigations will be required on chemical, enzyme, microbiological and pharmacological problems which are basic to practically all crops, and the solution of which will open the way to applications of great importance to agriculture. The color and/or flavor of processed products, whether for food or industrial use, play an important part in influencing the commercial value of the commodities.

General Plan: In general, basic work is conducted under this appropriation and applications made at 12 field stations located in areas where production of the crops involved is greatest. Cooperation is maintained with other Bureaus of the Department and State Agricultural Experiment Stations.

Progress and Current Program: The following statements of current programs and examples of recent accomplishments under this appropriation are cited by financial projects:

Fruits, Vegetables, and Other Agricultural Products of the South: Work under this project is concerned with (1) the production of canned citrus juices and concentrates of improved initial and storage quality, (2) development of uses for citrus byproducts and wastes, (3) brine preservation of vegetables, and (4) processing of agricultural materials for feed purposes.

Citrus Juices and Concentrates. Florida and Texas annually produce over

100,000,000 boxes — nearly 4,500,000 tons -- of citrus fruits, and production is increasing. About two-thirds of the grapefruit and a fourth of the oranges are now processed, largely for canned juices, and growers are looking to processing as an outlet for an even greater proportion of their crops.

As a part of the Southern citrus research program, studies have been continued on the causes of gas formation in orange juice concentrates, and the improvement of methods of pasteurization. Viable yeasts were isolated from such concentrates, and data were obtained on the time required to destroy them in concentrated sugar solutions at various temperatures. It was found that temperatures for effective pasteurization of such concentrates may be over 50° F. higher than those required in the case of whole fresh juice. Other studies have shown that spoilage from gas formation may be brought about not only by microbial fermentation, but also by chemical means, such as reaction between citric acid and sugars. Recommended processing procedures already developed from these studies have been commercially applied, with the result that during the 1943-44 season over 2,000,000 gallons of orange concentrate were shipped for military and lend-lease use with negligible losses from gas formation.

Emphasis is being placed not only upon maintenance of quality during storage of citrus juices, but on improved initial quality as well. Cooperative work with the Florida Citrus Commission has led to the filing of a public service patent application for an improved concentrate prepared by vacuum concentration of citrus juice to a high solids content, using the best present practice, and adding sufficient fresh juice to improve flavor and aroma and produce the desired final concentration. Also, preliminary pilot-plant-scale experiments have been made on the applicability to citrus juice concentration of the flavor recovery process developed at the Bureau's Eastern Regional Research Laboratory for use with apple juice. Further work will be necessary before it can be established that the process will give the same results with citrus as we have secured with apples. Much remains to be done to improve the quality of both straight and concentrated canned citrus juices to expand their marketing for civilian consumption. This problem was recognized in a conference held between interested Bureau units and members of the industry, at which considerable attention was given to the planning of a broad, coordinated research program on both Southern and Western citrus fruits. This program will include a thorough survey through the literature and by available analytical methods of minor compounds which may contribute to the objectionable flavors or poor keeping quality of processed citrus juices. Attention will also be given to those constituents which are responsible for the natural flavor, and to means of preventing alteration or loss of these substances during processing. The identity and characteristics of the bacteria and other microorganisms found in citrus fruit will be given further and more detailed study.

Byproduct Utilization. Progress has been made on the development of profitable uses for byproducts and waste materials from the canning of citrus juices. Florida production of stock feed from citrus pulp more than doubled between the 1940-41 and 1943-44 seasons, and now exceeds 70,000 tons annually. Production of this valuable byproduct in Texas has

expanded rapidly, with the technical assistance of Bureau personnel. More complete and profitable utilization of the liquor pressed from this pulp is being attained through commercial application of methods developed by the Bureau. During the past season alcohol was commercially produced from the concentrated press liquor; also, the dilute liquor was commercially used for growing high-protein feed yeast for the enrichment of stock feed.

The future byproducts program will include further work on the use of dilute and concentrated citrus press liquors for fermentations to produce lactic acid, ethyl and butyl alcohols, etc., as well as for production of feed yeast. More economical methods of drying pulp for stock feed will be studied. Attention will be given to new or improved methods for recovery and utilization of peel oil, seed oil, and other minor constituents of citrus fruit. Economical means will be sought for the sanitary disposal of dilute press liquors where their industrial utilization is impracticable.

Brined Vegetables. Continued interest of large canners in the commercial possibilities of salt- and brine- preserved vegetables, particularly for use in soups, led to further refinement of procedures for this method of preservation. Some 20 different vegetables can be successfully handled by appropriate salting or brining, the wide applicability and simplicity of the methods having been demonstrated by extensive practical use during the past seasons. A survey has been made of the availability of end-of-season surpluses of a variety of vegetables at production centers in Florida to determine the large-scale applicability of brine preservation to recovery and profitable utilization of this potentially valuable produce. Future studies of the salt-brining preservation process will emphasize the economic factors involved in its application to various vegetables.

Ensilage of Potatoes. In cooperation with the North Carolina Experiment Station, studies were continued on the ensilage of cull white potatoes. Fundamental information was obtained on the organisms present and the course of fermentation in potatoes that are steamed and ensiled hot. The method resulted in silage of excellent quality, which is being used in dairy cattle feeding tests.

Sugars and Sirups Investigations: Work under this project is concerned with (1) recovery of aconitic acid from sorghum and sugarcane juices, (2) recovery of sugarcane wax from clarification wastes, (3) reduction of sugar losses in beets during storage and transport, and (4) use of agricultural products in confectionery.

Aconitic Acid. The Bureau's patented process for recovering aconitic acid from sorghum juices which was developed during previous seasons, was successfully applied to sugarcane molasses this year. In cooperation with the Iberia Sugar Company, a growers' cooperative, several tons of calcium aconitate were produced on a pilot-plant scale by variations of the method of liming, and combined lime and calcium chloride treatment of the diluted second molasses. The success of this work has led the Iberia Company to install equipment for commercial-scale production of calcium aconitate from its entire grind of cane during the coming season. An incidental result of the aconitate recovery treatment is an increase in purity of the

molasses, permitting higher sugar recovery. A public service patent was drafted on a method developed for freeing the crude calcium aconitate of magnesium, an impurity which interferes with the efficient conversion of the aconitate to the commercially valuable aconitic acid.

A general survey demonstrated the availability of aconitic acid in all but one small Louisiana cane-producing area, and indicated a potentially available domestic supply of 6,000,000 pounds yearly. Experiments also developed the possibility of multiple harvesting of certain canes during the off-season solely for manufacture of aconitate and byproduct feed.

The future program will include continued efforts to industrialize the aconitic acid recovery process, as well as studies of the chemistry of aconitic acid and its derivatives and their industrial application.

Sugarcane Wax. The Bureau's process for refining sugarcane wax extracted from clarification residues was further improved by development of a method for crystallizing the wax from concentrated solutions in the extraction solvent, usually toluene. This permits rapid and thorough washing to remove fatty and colored impurities, and results in a premium quality powdered wax. This process is already being applied commercially. However, continued efforts will be made to improve the efficiency of commercial operation. Further studies will be made of the composition and utilization of the wax.

Losses in Sugar Beets. Further progress was made in the study of methods of minimizing losses of sugar in beet storage piles, and in carloads of beets in transit. A detailed publication was prepared on careful evaluation of the savings to be effected by application of whitewash to the surface beets, and wider adoption of the practice is anticipated throughout the beet sugar industry. Composite samples from 65 beet sugar factories were analyzed and examined bacteriologically, and the data were issued for the guidance of producers in maintaining and improving the quality of sugars produced and increasing efficiency of manufacturing operations. This marks an important step in the solution of the problem of beet spoilage in storage piles and in carloads in transit.

Confectionery. In cooperation with the National Confectioners' Association, investigations are being made of the use of a wider variety of agricultural products in confectionery, with particular emphasis on improving the nutritional balance of various types of candy. Commercially available cottonseed, peanut, soybean, sunflower seed, and similar flours are being tried, as well as alcohol-extracted soy flour and starch sponge developed at the Northern Regional Research Laboratory, Velva-Fruit purees of the Western Regional Research Laboratory, and apple "sirup" concentrates from the Eastern Regional Research Laboratory. A specially prepared protein isolated from peanut meal has already given exceptional promise as a suitable candy ingredient for attaining a desirable balance of protein in relation to carbohydrate content. A patent disclosure has been prepared covering the use of this and similar preparations as candy ingredients.

Work under the project "Inulin and other Complex Polysaccharides Investigations" will be completed and closed out in 1946. The closing of this

line of work will provide funds greatly needed for cane sugars investigations to determine the causes of, and to develop methods of overcoming difficulties in processing mechanically harvested sugar cane and new varieties of cane.

Investigations on Pharmacology of Agricultural Products: The pharmacological research group has continued its functions of determining the pharmacological properties, including possible acute and chronic toxicity, or products having prospective uses as foods, feeds, medicines, or pharmaceuticals, and of studying contaminants that occur in foods as a result of their processing. Research of this nature has served not only as a protective measure, but also as a source of new and valuable information, and frequently as a stimulus and guide to new investigations.

Some products currently under study are the new antibiotics, citrinin, lysozyme, and subtilin, as well as carotene, the precursor of vitamin A. It was recently indicated that all of the carotene present in dehydrated carrots may not be usable by test animals; from this it seems possible that dehydration causes some of the natural carotene to become biologically unavailable. Lysozyme, prepared from egg white, has been shown to be capable of producing anaphylaxis in rats and guinea pigs.

Investigations on Enzymes and Phytochemistry: The Enzyme Research Laboratory has continued to investigate applications of enzyme chemistry to agricultural problems.

The so-called sulfite process for making industrial alcohol from wheat, described in previous reports, has saved industry a quarter of a million bushels of malt. A method for the rapid digestion of uncooked starch has been developed that converts all the starch to sugars and thus shows promise of important application. The difference between malt made from western barley (which makes poor malt) and eastern barley (some of which makes high-grade malt) has been discovered. By addition of certain cheap materials such as sweetpotato juice or extracts of wheat meal to the poor malt, its quality can be made to equal that of high-grade malt. This improvement occurs because the added materials supply an enzyme that is lacking in low-grade malt.

Work along such lines as the foregoing will be continued, and attention will be given to agricultural processes such as ripening, particularly the ripening of grains and citrus fruits in the hope of devising artificial aids to ripening that will improve the quality and storage life of these products.

Fruits, Vegetables, and Other Agricultural Products of the West: Work under this project is carried out jointly in Washington State and California, and is concerned chiefly with (1) improvement of freestone peach canning, (2) removal of nightshade berries from peas, (3) utilization of pear cannery wastes, and (4) processing of Western citrus fruits.

Freestone Peaches. A cooperative project with the Washington State Agricultural Experiment Station has served the recently-developed freestone peach canning industry. The effect of such variables as variety, harvest

maturity, ripening, and storage has been evaluated in experimentally canned samples. Studies of discoloration in stored peaches showed that metallic contamination was not responsible, the chief factor being residual oxygen in the headspace of the can. Optimum ripening conditions were determined for commercial blocks of peaches. Present work is concerned with lowering production costs and developing improvement in quality.

Nightshade Berries. Experimental work has been continued on the improvement of the process previously described for the removal of nightshade berries during the canning of peas. The method, which involves the treatment of the pea-berry mixture with an oil-water emulsion in which the nightshade berries and debris are coated with air bubbles and floated away while the peas sink, has been shown to be commercially feasible. Improvement in operating details may be expected as the result of further research.

Pear Wastes. In efforts to utilize the sugars of pear cannery wastes, a lime treatment has been developed by which colloidal impurities can be economically filtered out to produce a clear pear juice. Studies are being continued to determine the practical limits of operation of this process.

Grapefruit Juice. About 2½ to 3 million cases of canned grapefruit juice are now being packed annually by the Arizona-California industry. It is estimated that this pack could be materially increased if the product could be improved. While mid-season fruit is fairly well balanced in quality, early grapefruit from these areas is too acid, while late-season fruit is not tart enough. Preliminary laboratory results have indicated that juice from early fruit can be given the proper balance between acidity and sweetness by addition of sugar and buffer salts; it may be possible to similarly standardize the juice from late fruit by addition of citric acid or its salts.

Cleaning Dates. Usual methods of cleaning ripe dates involve rolling them over Turkish towels, which entails undue expenses for laundering the towels. A new procedure has been developed for cleaning the dates by tumbling them through warm water sprays and drying them in circulating warm air. The process has been adopted by a commercial date packer.

Fundamental Investigations in Microbiology of Agricultural Products: The rapid growth of the egg dehydration industry during the war, because of the demand for a nutritious food product requiring a minimum of shipping space, exceeded growth of the scientific knowledge necessary for the manufacture and handling of a high quality product. To insure the consumer against spoilage and health hazards, investigations have been and are being undertaken to obtain basic information needed to improve the microbiological quality of egg powder.

Both high- and low-moisture-content powders have been examined in the laboratory, and their production methods have been studied in the field. The findings have shown that (1) dirty shell eggs are an important source of food poisoning organisms; (2) pasteurization of the liquid

egg mix, and a low moisture content in the egg powder, greatly discourage the growth of such organisms; (3) they may survive several months in powder stored at 86° F. or less; and (5) the bacterial count in high-moisture powder varies seasonally, being lowest in the spring and early summer months.

Results of laboratory and field studies have been prepared for publication and otherwise made available to the industry and interested government agencies.

The current program includes projects on (1) improvement of methods for isolation and quantitative estimation of food poisoning organisms occurring in egg powder; (2) serological identification of common and unusual types of such organisms; (3) biochemical differentiation of similar strains; and (4) determination of effective pasteurization times and temperatures for liquid egg mix prior to dehydration.

Tung Nut Investigations: Largely as a result of the Bureau's pioneer work on the application of solvent extraction techniques to tung nuts, the tung oil industry is considering the installation of a 50-ton solvent extraction plant in the Louisiana-Mississippi area as a means of increasing domestic supplies of this very important drying oil. During the past year considerable progress was made on a careful evaluation of various available solvents as to economy, efficiency, and quality of tung oil obtained. Pilot plant studies in a continuous commercial counter-current extractor indicated that two of the most suitable solvents were two hydro-carbons, hexane and heptane. Oils extracted by both solvents were made into excellent spar varnishes. The study of further details of commercial processes for tung oil extraction is going forward.

Introduction during the past season of field hullers necessitated careful study of methods of promptly drying the hulled tung fruit kernels. Tests were made in several types of commercial and experimental driers to determine the effect upon extractability and oil quality of drying hulled kernels at various controlled temperatures. Data also were obtained for calculation of drying capacities, efficiencies, and approximate costs.

During the fiscal year 1946 work will be conducted on the utilization of byproduct tung hulls and meal, and on the effect of tung nut storage on oil quality.

Basic Investigations in the Chemistry of Agricultural Products: A small technical staff has been organized to conduct fundamental investigations in plant biochemistry in cooperation with plant breeders, physiologists, and pathologists. Part of the work has been directed intensively to the synthesis of new compounds to be tested for plant hormonal and/or phytocidal action. This is important since the discovery of compounds which will hasten fruit ripening or selectively kill noxious plants without harming useful crops, will effectively increase farm production.

Emphasis is being placed on the so-called weed killers, which belong chiefly in the family of substituted phenoxyacetic acids. Efforts will be made to discover compounds which are more potent than those now in use, cause the least damage to useful plants, and can be characterized by readily detectable chemical groups so that the mechanism of their action can be determined.

(c) Naval Stores Investigations

Appropriation Act, 1946		$125,000
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+17,500
Total anticipated available, 1946		142,500
Budget estimate, 1947		140,000
Change for 1947:		
Overtime decrease	-2,100	
Other decrease	-400	
		-2,500

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Naval Stores Investigations:				
(a) Investigations of naval stores production, processes and equipment	$31,378	$49,006	$48,856	-$150
(b) Investigations of composition, properties, components, and derivatives of naval stores	33,181	42,499	42,399	-100
(c) Investigations of uses, handling, and transportation of naval stores	31,256	48,895	48,745	-150
2. Overtime pay	13,547	2,100	- -	-2,100
Covered into Treasury as miscellaneous receipts, P.L. 529	56	- -	- -	
Unobligated balance	23,242	- -	- -	
Total available	132,660	142,500	140,000	-2,500
Anticipated supplemental	- -	-17,500	- -	
Total estimate or appropriation (1945 adjusted for comparability)	132,660	125,000	140,000	

INCREASES OR DECREASES

The decrease of $2,500 in this item for 1947 consists of the $2,100 decrease for overtime, and a decrease of $400 to round off the appropriation total.

It is further presumed that these entities can be isolated by fractionation procedures employing chemical, physical, and biochemical techniques. The specifically active components of immunological reactions are chiefly of protein character. Hence, for identification of these proteins, laboratory animals will be employed for conducting immunologic identification tests. When results of experiments conducted under this project justify clinical tests on farm animals, arrangement would be made with the Bureau of Animal Industry for collaborative studies to be conducted by and under direction of that Bureau.

CHANGE IN LANGUAGE

The estimates include a proposed change in the language of this item, as follows (new language underscored, deleted matter enclosed with brackets):

> Agricultural chemical investigations: For conducting the investigations contemplated by the Act of May 15, 1862 (5 U.S.C. 511, 512), relating to the application of chemistry to agriculture; for the biological, chemical, physical, microscopical, and technological investigations of foods, feeds, drugs, plant and animal products, and substances used in the manufacture thereof; for investigations of the physiological effects and for the pharmacological testing of such products and of insecticides; for the investigation and development of methods for the manufacture of sugars, sugar sirups, and starches and the utilization of new agricultural materials for such purposes; and for the technological investigation of the utilization of fruits and vegetables and for frozen pack investigations; [and to cooperate with associations and scientific societies in the development of methods of analysis, $350,000] $576,000.

The proposed change in language deletes the words "and to cooperate with associations and scientific societies in the development of methods of analysis" for the sole purpose of shortening and simplifying the wording of the item. The clause proposed for deletion is considered surplusage and, therefore, need not be retained in the annual appropriation act, the cooperative work being authorized by the Act of May 15, 1862 (5 U.S.C. 511), establishing the Department of Agriculture, as implemented by the Act of July 24, 1919. (5 U.S.C. 563-564). Elimination of the language from the annual appropriation act will not in any way change the scope or character of the work performed under this appropriation item, or the authority of the Department to cooperate with other agencies, institutions, organizations, or others in the conduct of such work.

In view of the proposed deletion of the last clause of the item, it is necessary to insert the word "and" at the beginning of the next preceding clause.

WORK UNDER THIS APPROPRIATION

Objective: (1) To develop improved methods and equipment for the production of turpentine and rosin in order to make available products more nearly meeting the physical and chemical requirements of the consuming industries; (2) to determine the chemical composition of pine oleoresin (pine tree gum) and the various turpentines and rosins in order to produce derivatives which may prove of industrial value; and (3) to develop methods of handling, packaging, and storing naval stores which will minimize deterioration.

The Problem and its Significance: With the transition from war to peace and its accompanying changes in price structure and increased competition with other products which have not been readily available owing to the war, it will be necessary to expand the effort to develop more efficient methods of processing the pine oleoresin and to develop new derivatives, thereby furnishing a wider market for naval stores products.

Pine oleoresin is the source of raw materials for synthetic rubber, protective coatings, for drying oil promoters, soap, various chemicals, such as camphor, cymene and styrene derivatives, and other chemicals. It is an annually reproducible crop with potentialities for increased production.

Future plans contemplate the conduct of studies on terpene and resin acid derivatives and the return, as far as possible, to the program of resin and rosin utilization as originally set up. Work on improved processing of gum, which was held back during the war, will also be intensified.

There is a continuing need for "intermediates" for making synthetic rubber and various chemicals and derivatives needed in the compounding of such rubbers.

Turpentine derivatives have been obtained which can serve in actual rubber synthesis both individually and in compounding products to impart to synthetic rubber specifically desired properties.

General Plan: The research and technical work conducted under this appropriation comprises studies on production, processes, equipment composition, properties, components and derivatives, and on uses, handling and transportation of naval stores. Results obtained from studies on composition and derivatives constitute a basis for studies on new uses and applications. Wherever possible, results obtained from studies on composition and new uses are translated into larger than laboratory scale work at the Naval Stores Station. The appropriation for "Naval stores investigations" is devoted to work connected with their effect on the development of a sound post-war economy in the naval stores industry.

Progress and Current Program: The work of the Naval Stores Research work of the Bureau has resulted in the issuing of 7 patents and other publications during the past year.

Investigations of Naval Stores Production, Processes, and Equipment: Research on naval stores has included studies of (1) improved gum

cleaning and refining methods; (2) continuous distillation of pine gum; (3) gum from chemically stimulated trees; (4) protective coatings for turpentine cups; (5) gum storage; (6) synthetic rubber intermediates from turpentine; (7) rosin soaps for synthetic rubber emulsifiers; (8) new and useful derivatives of rosin; and (9) collection of naval stores statistics.

Progress was made in the development of methods for the continuous steam distillation of pine gum. A continuous still of semi-commercial size was erected, and performance tests were started. The present capacity of this still is equal to that of the batch stills now in commercial use, although its steam consumption is only two-thirds as great.

For the benefit of naval stores producers, a bulletin was issued showing drawings of typical processing equipment and a suggested plant layout for carrying out the Bureau's patented process for gum cleaning and refining. As in previous years, licensed commercial production by this process was again at least 40,000,000 pounds of high grade rosin and some 1,500,000 gallons of turpentine. Five new central refineries are being built this season to operate under this patent.

Further research in cooperation with the Forest Service on gum from chemically stimulated trees has confirmed that rosin and turpentine of good quality can be made from such gum under suitable processing conditions. Work is continuing on the continuous distillation process, and efforts will be made to develop a continuous gum cleaning process. Further studies will be made of the effect of chemical stimulation, as well as on protective coatings for extending the life of turpentine cups and methods of gum storage to permit year-round operation of central refineries.

Investigation of Composition, Properties, Components, and Derivatives of Naval Stores: Work has been continued on the development of synthetic rubber imtermediates and other useful products from turpentine, to help meet wartime shortages and to find new outlets for naval stores. A method has been developed for the liquid-phase conversion of alpha-pinene, the chief component of turpentine, to its isomers, dipentene and allo-ocimene, and for the further conversion of the latter to a substance known as pyronene. A number of synthetic rubber-like elastomers have been prepared from the turpentine derivatives isoprene and myrcene, by copolymerization with styrene; some of these show considerable promise. For the more efficient separation of turpentine derivatives, new vacuum distillation was set up. Samples of purified isoprene and myrcene were prepared and furnished to industrial and college laboratories for polymerization studies.

Further work is in progress on the isomerization or decomposition of the components of turpentine, and on the polymerization of the products thus obtained to produce rubber-like elastomers.

Investigations of Uses, Handling, and Transportation of Naval Stores: A new method was developed for the esterification of rosin with slow-reacting polyhydric alcohols, such as 2,3-butylene glycol, whereby after

a preliminary reaction of the rosin with lactic acid, the time required for esterification is reduced by 50 to 60 percent. Another method was developed for preparing the propylene glycol ester of rosin, which should serve as a satisfactory replacement for ester gum, the glycerol ester of rosin.

Synthetic rubber prepared by the copolymerization of butadiene and styrene in an aqueous emulsion, using soaps of rosin and resin acid derivatives as emulsifying agents, was found to be superior to that prepared with fatty acid soaps as the emulsifying agents.

In accordance with Public Law 278 - 74th Congress, data were collected, tabulated, and published on the production, distribution, consumption, and stocks of naval stores by quarters. Monthly surveys of naval stores stocks and monthly reports on the production of steam distilled wood naval stores also were issued during the year.

Work is continuing on the preparation of rosin acid derivatives and on the preparation and purification of stabilized rosin acids for use in synthetic rubber polymerization processes; on the esterification of rosin and rosin acid derivatives; and on the compilation of naval stores statistics.

(Continued on next page)

(d) Regional Research Laboratories

Appropriation Act, 1946		$4,000,000
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+500,000
Total anticipated available, 1946		4,500,000
Budget estimate, 1947		4,450,000
Change for 1947:		
Overtime decrease	-66,000	
Increase	+16,000	-50,000

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Southern regional research laboratory	$886,926	$1,073,675	$1,075,865	+$2,190
2. Western regional research laboratory	852,944	1,078,675	1,081,065	+ 2,390
3. Eastern regional research laboratory	868,246	1,068,875	1,072,265	+ 3,390
4. Northern regional research laboratory	888,757	1,075,335	1,083,365	+ 8,030
5. General administrative expenses	88,604	137,440	137,440	- -
6. Overtime pay	488,032	66,000	- -	-66,000
Covered into Treasury as miscellaneous receipts, P.L. 529	864	- -	- -	
Unobligated balance	170,227	- -	- -	
Total available	4,244,600	4,500,000	4,450,000	-50,000
Anticipated supplemental	- -	-500,000	- -	
Total estimate or appropriation	4,244,600	4,000,000	4,450,000	

INCREASES OR DECREASES

The net decrease of $50,000 for 1947 consists of the $66,000 decrease for overtime, and an increase of $16,000 for placing on a full-year basis in 1947, within-grade salary advancements which are estimated to be in effect for only part of the fiscal year 1946, the amount applicable to each of the four regional research laboratories being indicated in the above statement.

WORK UNDER THIS APPROPRIATION

Objective: To develop, by research, new scientific, chemical, and technical uses and new and extended markets and outlets for farm commodities, and products and byproducts thereof, including food products such as corn, wheat, soybeans, cotton, sweetpotatoes, peanuts, apples, vegetables, tobacco, milk products, animal fats and oils, tanning materials, hides, skins and leather, potatoes, alfalfa, fruits, poultry, and agricultural residues. Efforts are concentrated on the development and improvement of processes which will make possible the profitable production of industrial products for which there is a present or potential demand, and to stimulate industries by showing the possibilities of financial profit from the processing of agricultural materials.

The Problem and its Significance: A basic problem and need of agriculture under normal peacetime conditions has been to develop new and extended uses and expanded outlets for its products and byproducts. The war emphasized the importance of the program of industrial utilization of farm commodities in certain and many of its more immediate aspects, in order to meet deficiencies in strategic and critical raw materials and to develop substitute replacement materials of great value for both civilian and military needs. Many low-grade and waste farm materials, as well as food crops, contain appreciable quantities of valuable constituents which serve for the production of plastics, synthetic rubber, motor fuels and lubricants, building materials, cloth filler and substitutes, fibers, protein meals, films, adhesives, medicines, pharmaceuticals, solvents, hormones, and other vital commodities.

Ample supplies of most farm commodities, together with surpluses of agricultural residues, constitute a reservoir from which to draw raw materials for such products and processes as are developed.

General Plan: The research work under this appropriation covers the principal agricultural commodities produced in the 48 States. Through chemical, physical and biological laboratory investigations, it is planned to develop new products and processes involving these commodities, and through chemical engineering research on pilot-plant scale, to establish the commercial feasibility of the given product or process leading to commercial development and use of these farm products.

During the war period, emphasis was placed on the development and improvement, from farm commodities, of products and processes which had immediate significance and application to war needs. Short-term problems, the solution of which would contribute to the war program, were emphasized. Long-term basic studies, as originally planned for these laboratories, are now being resumed to meet peacetime needs.

Indicated below are the States to be served, together with the commodities to be given primary attention, by each of the laboratories:

Southern Regional Research Laboratory, New Orleans, Louisiana

Area	Commodity
Alabama	Cotton
Arkansas	Sweetpotatoes
Florida	Peanuts
Georgia	
Louisiana	
Mississippi	
Oklahoma	
South Carolina	
Texas	

Eastern Regional Research Laboratory, Wyndmoor, Pennsylvania

Area	Commodity
Connecticut	Apples and other fruits
Delaware	Vegetables
Kentucky	Tobacco
Maine	Milk products
Maryland	Potatoes
Massachusetts	Animal fats and oils
New Hampshire	Tanning materials, hides, skins and leather
New Jersey	
New York	
North Carolina	
Pennsylvania	
Rhode Island	
Tennessee	
Vermont	
Virginia	
West Virginia	

Western Regional Research Laboratory, Albany, California

Area	Commodity
Arizona	Alfalfa
California	Fruits, including apples
Colorado	Vegetables, including potatoes
Idaho	Poultry
Montana	Wheat
Nevada	
New Mexico	
Oregon	
Utah	
Washington	
Wyoming	

Northern Regional Research Laboratory, Peoria, Illinois

Area	Commodity
Illinois	Agricultural residues
Indiana	Corn, wheat, and other cereal crops
Iowa	Soybeans and other oilseed crops
Kansas	
Michigan	
Minnesota	
Missouri	
Nebraska	
North Dakota	
Ohio	
South Dakota	
Wisconsin	

It will be noted that research on certain of the commodities has been divided between two laboratories. Such division of effort is based on the importance of the commodity under investigation in the regional areas to which assigned. Careful consideration has been given to the composition of these commodities which suggest different types of utilization and to the coordination of the research activities of the laboratories concerned.

The research program for each laboratory, by commodities, is briefly discussed in the following statements:

Southern Regional Research Laboratory

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)
1. Cotton utilization investigations	$713,835	$859,125	$860,700
2. Sweetpotato utilization investigations	123,348	150,310	150,735
3. Peanut utilization investigations	49,743	64,240	64,430
4. Overtime pay	118,508	16,500	- -
Covered into Treasury as Miscellaneous Receipts, Public Law 529	270	- -	- -
Unobligated balance	14,896	- -	- -
Total available	1,020,600	1,090,175	1,075,865
Anticipated supplemental	- -	-120,335	- -
Total estimate or appropriation	1,020,600	969,840	1,075,865

Examples of Progress and Current Program:

Cotton Utilization Investigations:

Cotton Tire Cord. Pursuit of a broad, coordinated program of research for improving the performance of cotton cord in tires has continued to be a major activity of the Southern Regional Laboratory. Several examples of accomplishments during the year are described below:

Four additional road service tests were made on tires containing special cotton cords, this making a total of six service tests completed to date. Although the Army and War Production Board have not yet released detailed results of the tests, it can be said that where carcass strength was a factor, tires containing the special cords previously mentioned consistently outperformed those made from regular style commercial cotton fabrics. The Wilds.13 variety of cotton gave outstanding results. The results so far obtained in comparison with rayon on truck tires are inconclusive. To obtain the maximum performance value from truck tires made from cotton cords, it appears that the cord will either have to be low-guage, or a thinner carcass must be used. Studies have been continued on the adhesive properties of tire cord when vulcanized into GR-S rubbers. Commercial gum dipping processes designed especially for rayon tire cords improved the adhesiveness of cotton cords only slightly. It was found, however, that by use of certain phenolic compounds such as resorcinol and pyrogallol in combination with formaldehyde and rubber latex, the adhesion of cotton cord could be improved from 25 up to 95 per cent.

It is well known that the strength of cotton and rayon cords decreases with increase in temperature. A special mercerization process developed for cotton yarns has led to substantially increased heat resistance in cords made from such yarns. The method has been shown to be practicable on commercial machines.

A newly developed method for determining the proportions of crystalline and amorphous cellulose in cotton fiber should prove a powerful tool in studies of the properties of cotton fiber and products made therefrom. Intensive studies have been made of the standard test methods and testing machines used to evaluate tire cord with a view to determining what these machines measure in terms of the fundamental physical properties of tire cord. It has long been known that the measured breaking strength of a textile material is a function of the rate of loading and the lapsed time to break. In the case of tire cord, it has been found that differences in the elastic properties of various types of cord are sufficiently great to affect appreciably the tensile strength measurements. For example, it is a widespread belief that the stretching process causes a high percentage increase in strength, but when these two types of cord are broken at the same lapsed time, the differences in their tensile strength are materially reduced. During the past year these studies have been particularly concerned with accounting for the difference in results obtained on the pendulum-type and the inclined-plane type of tensile-testing machines.

The program of work for the future includes determination of the effect of moisture upon flex life and other properties of tire cords; further investigation of the hysteresis of heat build-up of tire cords and carcasses; further improvement of the adhesion of cotton cords to synthetic rubber; intensification of studies of the influence of cord construction on tire cord properties; and commercial evaluation of the "dual stretched" cord treating process developed by the Southern Laboratory.

Supplementing Linters - Cotton linters remain the principal source of cellulose for the manufacture of smokeless powder. The commercial size cutter for reducing lint cotton to the length of chemical grade linters, mentioned in last year's budget presentation as being under construction, was completed and tested at the linter purification plant of the Buckeye Cotton Oil Company. Results of the production tests were favorable and the War Production Board has contracted for a double-battery unit to be designed and constructed at the earliest possible date to process first-run linters in addition to lint cotton. The Office of Production Research and Development of War Production Board had allocated the funds to finance construction of this large unit by the Buckeye firm.

Preservation against Microorganisms and Weather. A general survey of rotproofing agents from the standpoint of effective protection afforded to cotton and jute sandbag fabrics was prepared for the Office of the Chief of Engineers, War Department, and the results of tests made on such materials were checked in a practical manner by an extensive series of service trials conducted with treated sandbags processed and manufactured at this laboratory. Data secured from these trials have been made available to the Corps of Engineers and to appropriate committees of the NRC

Tropical Deterioration Project Army-Navy-14. Several new chemical compounds have been received and evaluated as rot-and-weatherproofing agents for cotton fabrics. A detailed study has also been made of the influence exerted upon cellulose degradation in weather exposure by a number of commercial treatments used to impart resistance to water, flame, or mildew. Partial acetylation of cotton threads and fabrics has been found to afford a high degree of protection against mildew and rotting, and much attention has been devoted to developing a continuous padding method for applying this treatment to cotton piece goods on a commercial scale. Continued cooperation will be given to the War Department in the development of improved textile products for the armed forces, and further attention will be given to methods of preserving cotton fabrics against decomposition by weathering and microorganisms and to techniques for the rapid evaluation of treated fabrics.

Surgical Bandage. Experimental development of new semi-elastic cotton bandage has appeared adequate for present purposes, except for the extension of experience in its clinical use, and attention has been largely devoted to supplying the U. S. Naval Hospital in New Orleans with a regular weekly quota of these bandages, in addition to complying with frequent requests from other sources for sample lots. From the many favorable reports received, it is apparent that this bandage meets a real need in clinical practice, and it is hoped that commercial production will soon be possible. Two large bandage manufacturers are now conducting experimental work with this end in view. The work on bleaching, started in connection with the bandage development, is being pursued as a separate line project. Fundamental data on cotton bleaching are being accumulated, so that results obtained in practice can serve as a standard of reference for the development of more rapid and more economical commercial methods. To secure more complete information about the effects of present commercial bleaching as a basis for improvement, arrangements have been made for cooperative trials at several southern finishing plants.

Finishes to improve Durability of Fabrics. Samples of a standard cotton fabric were treated with solutions of different durable-type finishing agents in concentrations previously determined as optimum for the various compounds employed. The finished samples were evaluated against an unfinished original for increased breaking strength and abrasion resistance, after which they were given an extended series of mechanical launderings and again tested. It was found that the properties imparted by some of these finishing agents were fairly well retained after the repeated launderings, the good abrasion resistance of cloth treated with an alkali-soluble cellulose ether being especially marked. There appear to be practical possibilities of improving cotton cloth characteristics, both in appearance and in weaving qualities, by combining a durable finish of this type with a regular mercerizing treatment. Work along this line has accordingly been initiated.

Flameproofing Cotton. A process described in last year's budget justification was developed to provide a practicable method of flameproofing cotton cloth suitable for clothing and capable of retaining its flame resistance after repeated laundering. Although meeting service requirements in

other respects, the treated cloth was deficient in its resistance to afterglow. Work this year has centered on attempts to minimize this afterglow as well as to improve the technique of application. It should be emphasized that the Southern Regional Laboratory emulsion flameproofing treatment as described previously does not cause a loss in fabric strength, and in spite of an afterglow of 3 to 4 minutes duration in the charred portion of the cloth, it remains, to the best of our knowledge the most satisfactory treatment available for the durable flameproofing of clothing material. Continued efforts will be made to improve the process, as well as to try out the present formula on a commercial scale.

The Coast Guard has shown considerable interest in this flameproofing treatment for use in life jacket envelopes and desires cooperative work on the development.

The possibility of the application of a commercial flameproofing process for fabric to cotton in raw stock form, has been examined and found quite feasible. The object of this work is to prepare cotton insulation which would have complete resistance to leaching by condensed moisture such as is encountered in refrigeration insulation.

Stabilization of Nitrocellulose. A full-sized lot (7,200 pounds) of pyro nitrocellulose was prepared, using the ammonia stabilization treatment developed by this Laboratory and described in last year's report. This large lot of powder was prepared in cooperation with the Naval Powder Factory at their plant at Indian Head, Maryland. This pilot run received 22 hours of boiling plus the cold water ammonia stabilization treatment as compared to 48 hours of boiling for the regular purification treatment. Laboratory runs indicate that the 26 hours' saving in time can be considerably increased, but this was not done on the test run in order to be on the safe side. The product successfully met all the usual routine laboratory tests and was fabricated into 5"/38 smokeless powder. The powder is receiving firing tests at the Dahlgren Proving Grounds. The Army Bureau of Ordnance was kept fully informed of all of this work at their request and with the permission of the Navy.

Nitrocellulose films are being produced from a low viscosity nonreducing cellulose, in order to determine whether or not absence of reducing groups will have a beneficial effect on nitrate stability.

Modified Cotton Fibers substituted for Imported Fibers. Under a cooperative arrangement with the Fish and Wildlife Service, various preservative treatments have been compared at the laboratory, at Duxbury Harbor, and at Pensacola on cotton seine twine. Results have shown that the furfuryl alcohol resin treatment developed in the Southern Laboratory is superior to any of the commercial treatments now used. New samples have been prepared, for testing this summer at the above mentioned places, using the results already obtained to further improve the treatment. Efforts will be directed toward production on a larger scale. A treatment suitable for application to cotton sewing cord in order to prevent its degradation while being used for the closure of paper fertilizer bags has been developed. The work was done at the request of the Office of Production Research and Development of the War Production Board. Two

thousand yards of cord were prepared and are being tested in bags by a commercial company.

Noncellulosic Constituents of Cotton. A program of work has been initiated on the noncellulose constituents of cotton which have not heretofore been investigated either in a qualitative or quantitative manner as thoroughly as cellulose, which constitutes approximately 95 per cent of the raw cotton fiber. A search of the literature has indicated that little or nothing is known of the organic acids present. These are known to vary as the reaction of various cottons differ considerably, some being alkaline. Investigations of the acid constituents of cotton fiber have led to the isolation and identification of malic acid. Samples of fiber examined have contained 0.4 to 0.5 per cent of this acid. Further investigation will be made on the variations in malic and other organic acids naturally occurring in cotton, which may have some bearing on the properties of cotton as related to processing methods and end uses.

Cottonseed Investigations. Research has continued on the development of replacements for imported fats and oils and the development of new fat and oil products. The fractional solvent crystallization process has been extended to the fractionation of the fatty acids of raw and hydrogenated cottonseed oil, and conditions have been determined for the practical separation of the liquid and solid acids. The development of new techniques for making new oils from the fractionated acids provides a means of producing certain industrially useful products, as, for example, low-titer oils for sulfonation, which cannot be obtained by fractionation of the oils themselves. These synthetic oils are to be made in sufficient quantities for end-use evaluation. An extensive investigation has been made of the methods of preparing fatty acid chlorides, essential intermediates for the preparation of synthetic glycerides of known constitution, and economical procedures have been outlined by which these chlorides will be produced on a fairly large scale.

Further contributions have been made to the methods and processes for improving the keeping quality of oils, fats, and shortenings through continuing investigations of the properties of antioxidants. There have been developed more reliable methods for the determination of certain chemical constituents in inhibiting the oxidation of fats and oils. It has been demonstrated that antioxidant concentrates may be prepared by low pressure steam distillation of cottonseed oil and that such concentrates may be used for the stabilization of fats and oils which are deficient in natural antioxidants. By means of a series of deodorizations at successively increasing temperatures, the volatile constituents of cottonseed oil have been separated into inactive fractions and fractions possessing marked pro-oxidant and antioxidant activity.

In the continued investigations on the enzyme systems of cottonseed, and on the nature of their activation and inhibition, a second compound unrelated chemically to ammonia, mentioned in previous reports, has been found effective in inhibiting the heating and rate of formation of free fatty acids in the oil during storage of the moist seed. This substance is a vapor from a readily available commercial synthetic detergent, and can

be used for treating cottonseed without modification of existing storage facilities. Three commercial mill-scale storage tests of the vapor treatment were conducted during the 1944-45 season on a total of 275 tons of moist cottonseed. The results obtained clearly demonstrate that it is possible to inhibit heating, free fatty acid formation, and increase in the color of the oil, by treating the moist seed with the vapors from the detergent. At the request of the cooperating mills, mill-scale storage tests will be continued during the 1945-46 season to further explore the efficacy of the treatment under extreme conditions of storage. A previously unreported pigment of the gossypol group, named gossycaerulin for its blue color, has been detected in cooked cottonseed. Methods of quantitative estimation of this pigment and two other pigments, whose original detection was reported previously, have been developed to a point which permits investigation of these substances in cottonseed as a function of seed maturity, storage and processing conditions. The pigments in cottonseed are of major importance in feeding because of possible toxic effects and in industrial utilization because of color in the derived products. Continued attention will be given to isolating and identifying cottonseed pigments, since the information obtained will have important applications in the development of solvent extraction processes.

Further information of both fundamental and practical nature has been obtained on the properties of the constituents of cottonseed meal and cake, particularly on the proteins and enzyme systems. The data obtained on the solubility and fractionation of the protein will be of particular importance in the development of methods of processing and utilization of cottonseed protein for industrial end uses.

To obtain materials needed for the investigations of cottonseed oil, protein and pigments, to evaluate processes developed in the laboratory, and to afford quantities of end products for industrial test and evaluation, semi-plant scale facilities are essential for processing cottonseed by both hydraulic and by batch and continuous solvent extraction, for refining, bleaching, deodorizing, hydrogenating, fractional solvent crystallization, and modifying of the oil, and for the extraction and preparation of proteins contained in the meal. All of these facilities are expected to be completed and available for use by the end of the 1946 fiscal year.

Peanut Utilization Investigations:

Analyses made on a large number of samples of Spanish, Runner, and Virginia peanut kernels in relation to U. S. Standards for Farmers' Stock Peanuts have been used to indicate and justify the current procedure of evaluation used by the Commodity Credit Corporation in purchasing peanuts from farmers, especially those designated as oilseed stocks. This procedure evaluates the farmers' lots of peanuts on the basis of the yield in per cent or in pounds per ton of sound mature kernels. It is justified on the basis of relative narrow limits of variation in the composition of peanut kernels for each type. The samples were collected by the Office of Distribution of the War Food Administration.

Results of an investigation on the methods of determination of moisture in peanut kernels have been useful to the Commodity Credit Corporation in

revision of the analytical methods specified for evaluation peanuts for its marketing program for the 1945 crop.

The investigations on the development of replacement oils and fats and of new fat and oil products from peanut oil, and on the fundamental physical properties of peanut oil and its derived and modified products have paralleled those on cottonseed oil (see Cotton Utilization Investigations, Cottonseed Investigations). Particular attention has been given to the evaluation of physical properties of particular importance in the development of modified fats and oils for edible purposes and in the investigations on solvent extraction process of extracting peanut oil. Investigations will be continued on the calorimetric and dilatometric properties of hydrogenated and unhydrogenated peanut oils and the application of these properties to the development of modified fats and to processes for producing these products.

Investigations on the flavor deterioration of peanut butter in relation to the stability of the butter oil indicate that the flavor deterioration is not related closely to the development of rancidity of the oil present or to the action of microorganisms. In accelerated aging tests, the loss of peanut butter flavor was found to precede mainly the development of peroxides in the oil. Further efforts will be made to determine the factors responsible for deterioration.

Investigation of the physical and chemical properties of peanut protein has been and is being continued to enhance the industrial utilization of peanut meal. Additional data have been obtained on the solubility and fractionation of the protein and the behavior of phytin and phytases in the peanut in reference to the protein. Viscosity measurements are indicated as a means of control and evaluation in the production, processing, and utilization of protein preparations for specialized purposes.

Further progress has been made in the investigation of the protein-water relationships of peanut protein leading to improved methods of the production of peanut protein hydrates reported previously. A patent application has been filed which covers a process of dewatering peanut protein curds to the amount which is required for the formation of protein-water complexed or hydrates. This process reduces the drying costs and provides a protein of relatively uniform ash content. The protein hydrates are tacky and, at pH values near neutrality, have flow properties which make them suitable for certain gluing operations, such as rewettable or gummed tape glues, for which vegetable proteins have been considered unsuited heretofore.

An inexpensive means of removal of the color from red skinned peanuts has been devised to permit preparation of peanut protein relatively free of color. This is accomplished by washing the shelled nuts with 0.5 per cent sodium hydroxide solution at room temperature, rinsing and drying before processing for oil and meal. This development eliminates the necessity of the use of white skinned peanuts to obtain peanut protein of satisfactory color properties for industrial uses.

The development of pilot plant processing of peanuts and peanut oil and

meal parallels that for cottonseed. (See last paragraph of Cotton Utilization Investigations).

Sweetpotato Utilization Investigations:

Sweetpotato Starch. The cooperative agreement between the Department and the U. S. Sugar Corporation covering cooperative effort in development of a sweetpotato starch industry became effective July 1, 1944. The commercial factory and accessory facilities at Clewiston, Florida, are practically completed after some unanticipated delays in delivery of certain items of materials caused by the war situation. Test runs were scheduled for July, 1945. Major attention during the 1945 fiscal year was given to technical advice and assistance to this enterprise in adjusting final details of layout, accessory equipment units and proposed procedures for operation and control, to permit effective translation of the Bureau's process for manufacture of sweetpotato starch to the new plant. Coordinated investigations in the laboratory and pilot plant of the Southern Regional Research Laboratory and the Laurel Starch Plant furnished additional data needed for initial control adjustments of process water volumes, water-solids relationships in screening and handling of pulp, pH and lime water balance, bleaching, modification, drying, sampling, and analytical control. During the fiscal year 1946 it is planned to continue technical assistance in the translation of the starch-manufacturing process to large volume operations, with a view to obtaining, as early as possible, maximum production of high quality starch.

A semi-plant size continuous centrifugal for thickening and purification of starch was placed in operation in the pilot plant and optimum operating conditions were established in a series of five runs on the starch from 2,000 to 2,500 pounds of sweetpotatoes. This centrifugal, designed and constructed especially for this pilot plant, is similar to the large commercial units used in the purification of starch from corn, wheat, and other sources and is similar to the commercial units installed in the new sweetpotato starch plant at Clewiston, Florida. Further studies with this unit will materially facilitate establishment of conditions for most effective separation of solubles and fine fiber or pulp from starch in the Florida plant and others that may develop.

Operation of the Laurel, Mississippi, Starch Plant was confined to a period of about six weeks because of the short supply of starch sweetpotatoes (about 55,000 bushels) which was caused by the critical shortage of farm labor in the Laurel area and inadequate transportation facilities. However, the operations provided opportunity to demonstrate the effectiveness of improved factory control procedures and the superior processing quality of the new L-5 sweetpotato which made up nearly all of the raw material. Important new data were also obtained on the processes of pulp screening, starch settling, and starch drying under factory conditions. The starch production was 528,850 pounds, of which about a quarter went to a dry battery manufacturer, about a half to a textile mill and some laundry customers, and about a quarter to food uses.

Complete data were obtained on the component balance and solids-water relationships in screening starch from pulp of the new L-5 sweetpotatoes

under actual factory conditions. The information acquired facilitates design of most efficient screening equipment and effective control of the prices. A further detailed investigation provided for the first time reliable data on the component distribution in starch settling, on the actual quantities of crude protein and sugars available for byproduct recovery, and on the losses of starch in the overflow. Further progress was made in improving the control of starch drying to increase uniformity and minimize degrading effects. Up-to-date data were obtained on actual starch manufacturing costs under factory conditions.

The efficacy of modern continuously indicating and recording pH meter equipment, in facilitating uniform maintenance of optimum pH and lime water proportioning in the grinding and screening processes was demonstrated by trials throughout the 1944 operations in the Laurel Starch Plant. The entire plant process was improved. The improved procedure for starch bleaching and its control again demonstrated its advantages in maintaining uniformity of starch quality; similarly the improved procedure for production of thin-boiling starch by acid modification again performed in highly satisfactory manner. Further laboratory investigations demonstrated that if the pH and temperature are reliably controlled any desired degree of modification can be produced and effected by proper regulation of the times of reaction. Effective over-all factory control has been facilitated by development of further improved procedures of laboratory analysis, which combined accuracy and rapidity.

Examination of the comparative gelatinization and paste viscosity characteristics of starch from different stages of the purification and finishing processes in the Laurel factory has revealed important information on the nature and degree of modification of the native starch which takes place in these processes, independently of special modification processes. Application of these findings in conjunction with effectively controlled special modification and blending, permits production of starches of uniform characteristics best adapted to specific uses.

The better the quality and uniformity of the sweetpotato starch placed on the market, the lower its cost of production, and the better its characteristics are adapted to different uses, the better are the odds in favor of building up such a demand as to encourage expanded sweetpotato starch manufacturing enterprise which will afford an outlet for the crop from additional southern farm acreage. With this in view, work is being continued on further improvements in grinding, extraction, and other starch manufacturing processes, and on further refinements in methods of chemical and engineering control. Additional investigations will also be made of bleaching, washing, dewatering, drying, blending, and other starch finishing processes, in order to obtain products best adapted to specific applications.

Byproducts of Sweetpotato Starch Manufacture. Application of the laboratory findings as to optimum conditions for propagation of feed yeast on sweetpotato starch fruit water has been made successfully on a small pilot plant scale. The yields obtained in laboratory runs, equivalent to 40 per cent or somewhat higher of dry yeast on the basis of the sugars present, have been duplicated with approximately 35-gallon batches in a

complete pilot plant unit comprising 50-gallon propagators and accessory equipment. A full-scale pilot plant with 750-gallon propagators has been designed; this will be assembled and put into operation as soon as equipment has been received. A continuous process, employing two-stage propagators has been developed which on a laboratory scale was shown to materially increase the output per unit of time, reduce the propagator capacity required for the same output as by the batch process, and materially reduce the expense of aeration; it is planned to develop this process further in larger-scale equipment. Preliminary trials indicate that the high speed continuous centrifugal used in starch purification may be used successfully for concentrating yeast. Preliminary experiments encouraged the prospect of successful propagation of feed yeast without prior separation of the protein from the fruit water. Simultaneous concentration of the yeast produced and of the coagulated crude protein would be the most economical means of recovering these byproducts for feed use.

Continuous coagulation and concentration of the crude protein in sweetpotato starch fruit water was effected in improved equipment on a semi-pilot plant scale, with results comparable to those from previous laboratory trials. Fresh fruit water from centrifugal purification of starch was found to handle much more satisfactorily than settling tank overflow which had stood 12-24 hours. Filtration under slight pressure so far seems the most satisfactory method of dewatering the thickened protein coagulum. Preliminary experiments encouraged the prospect of simple and economical collection of the precipitated proteins on the byproduct pulp by percolation through a layer of the latter. In continued investigations on the constitution of the crude protein, a total of approximately 56 per cent of the nitrogen in the material has been accounted for in quantitatively determined and identified amino acids; around 11 per cent has been identified as amido nitrogen, and about 4 per cent in sulfur-carrying combination not yet specifically identified.

Data on the crude protein and sugars in the waste fruit water during an 84-hour run at the Laurel Starch Plant last fall indicated that recovery of crude protein and propagation of feed yeast with the same efficiency as in the pilot plant trials and return of the products to the pulp would have produced around 31 tons of byproduct feed containing about 13.5 per cent crude protein as compared with the actual production of 24.5 tons of pulp containing 1.69 per cent crude protein. Further large-scale tests are anticipated.

With establishment of the most effective and economical procedure for enzymic saccharification and removal of residual starch from sweetpotato pulp, the basic laboratory work on extraction of pectin from such pulp was completed. The data obtained will be applied on a larger scale to evaluate the feasibility of recovery of this byproduct in connection with sweetpotato processing and to prepare sufficient quantities of the pectin to evaluate its specific qualities.

Dehydration of Sweetpotatoes for Food Use. Experiments showed that, with good raw stock, with adequate storage conditions, and with proper preparation of the material for dehydration, a satisfactory and acceptable dehydrated product can be made from sweetpotatoes at any time from immediately after harvest until 6 months later. For optimum quality in respect

to flavor and color, a short storage period of 30 to 60 days is preferable to either no storage or to extended storage. Technical advice and assistance were rendered Sweet Potato Growers, Inc., in improvements in equipment and process in the dehydration plant at Laurel, Mississippi. The plant delivered to the Army a total of 901,032 pounds of acceptable finished product during the past season.

Western Regional Research Laboratory

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)
1. Alfalfa utilization investigations	$ 19,900	$ 33,200	$ 33,300
2. Fruit including apple utilization investigations a/	263,787	321,100	326,400
3. Poultry utilization investigations	187,570	254,200	254,700
4. Vegetable including potato utilization investigations a/	310,195	382,875	388,400
5. Wheat utilization investigations b/	64,540	78,200	78,265
6. Tanning materials - western hemlock bark as an emergency source	6,952	9,100	- -
7. Overtime pay	115,642	15,000	- -
Covered into Treasury as Miscellaneous Receipts, Public Law 529	275	- -	- -
Unobligated balance	64,339	- -	- -
Total available	1,033,200	1,093,675	1,081,065
Anticipated supplemental	- -	-123,835	- -
Total estimate or appropriation	1,033,200	969,840	1,081,065

a/ - Joint project with Eastern Regional Research Laboratory.
b/ - Joint project with Northern Regional Research Laboratory.

Examples of Progress and Current Program:

Fruit Including Apple Utilization Investigations:

Frozen Fruits and Frozen Fruit Products. It is common knowledge that the frozen-food industry is developing rapidly, and present industrial plans for expansion indicate a growth comparable to that of the canning industry in its earlier history. The commercially frozen pack of fruits in 1944 amounted to slightly over 160,000 tons. Research, appropriately applied, will make economies possible, will also protect and improve quality, and will develop hitherto unknown products such as Velva Fruit. Many of the Western Regional Research Laboratory staff members have worked on frozen foods, in the Western Regional Laboratory and other Government laboratories, for over ten years; the program of research is thus a continuous one, with considerable background of achievement.

Recent achievements can be summarized briefly as follows: (1) Introduction of sodium bisulfite solution, at about pH 3, as a replacement for sulfurous acid solution in the prefreezing treatment of apricots and peaches (and also apples) for pie fruits has improved working conditions by making possible the avoidance of obnoxious sulfur dioxide fumes. (2) A new catechol test detects quickly any remaining enzyme activity in treated fruits. (3) Velva Fruit, a new type of frozen fruit dessert developed in the Western Regional Research Laboratory, is receiving large-scale commercial trial. Minor improvements have been made in formulas during the past year. (4) A new type of frozen-fruit product, tentatively called cold-processed gelled fruit, has been developed and will be publicized and given commercial trial soon. This product is unique in its method of preparation and quality; it requires no heating and it preserves the natural aroma, flavor, and nutritive factors of the fruits in a highly satisfactory manner.

There is extensive commercial interest in the laboratory's research on frozen fruits, and also other frozen products. Visitors, inquiries, requests for publications, and requests for material to be published are numerous.

Freezing Preservation of Apple Slices. Increase in commercial use of frozen apple slices in pies during the past few years has meant a demand for improved methods of pretreating the slices for control of enzymic darkening. This phase of the apple industry was practically unknown before the war; now it is increasing at a rapid rate, which suggests with considerable definiteness that the rapidly developing freezing industry may be of future importance in commercial use of apple products. Estimates indicate that frozen slices are now being used to the extent of about 20,000 tons annually in the United States.

Among the technical problems related to freezing of apple slices, the control of enzymically catalyzed oxidative darkening is fundamental and has required first attention. Several methods, including scalding in steam, water, or sirup, treatment in solutions containing sulfur dioxide, and use of new and less-well-known antioxidant preparations offer possibilities. Among these the use of sodium bisulfite has proved convenient and is effective, provided the treatment is properly applied.

During the past year a report of studies on treatment of apple slices in sodium bisulfite solution, as compared with other methods, was published in a mimeographed circular, which has been printed by four food trade journals. The bisulfite solution has the advantage of being inoffensive in odor when applied, as compared with sulfurous acid, as well as the further advantage that it avoids the loss of sugar and flavoring substances that occurs during scalding of the slices.

A simple test involving use of catechol to detect extent of penetration of sulfur dioxide into treated fruit has proved useful in the treatment of apple slices. Bisulfite solution penetrates more slowly than sulfurous acid does and therefore a holding period is necessary with bisulfite, prior to freezing, to allow for this penetration. A report on the catechol test, which is also useful in measuring adequacy of scalding in

fruits, was published in a food journal. The commercial importance of treatments of frozen fruits with sulfur-containing materials has prompted the development of a method for the determination of sulfur dioxide in fruits, with special adaptation to fruits preserved by freezing.

Future work will continue in the following directions: (1) Use of antioxidants, such as ascorbic acid, and inactivation of enzymes by sirup and steam scalding and by chemicals containing sulfur dioxide; (2) preparation of coarse purees to be used as applesauce and fine purees for Velva Fruit, including use of antioxidants and flash heating; (3) estimation of effect of length of storage period on quality of Gravenstein apples.

Use of Propionates to Control Spoilage in Fresh Fruits. Extensive studies have now been made on the application of weak solutions of calcium and sodium propionate to fruits and fruit purees (as well as vegetables) in an effort to determine the effectiveness of these solutions in controlling microbiological spoilage in fresh products. If such applications prove feasible they will be beneficial in controlling losses and in protecting quality of fresh products during periods when they must be held at atmospheric temperatures. Berries, for example, are highly perishable. Other fruits are sometimes lost through necessary delay in being handled. Control of spoilage during short periods has been demonstrated, and treated products have suffered no apparent ill effects as a result of treatment. Propionate is used to prevent mold in bread and is present in certain types of cheese; the question whether it is legally applicable to fresh fruits and vegetables remains to be determined.

Dehydration and Concentration of Fruits and Fruit Products. The laboratory has been devoting a large share of its facilities to dehydration and this research has included work on equipment and other general problems, which is of interest to all dehydrators of foods. Specific research has been applied to the compression of apple nuggets (chopped dried apples, dried further to very low moisture contents). Compression makes economies in space possible. New equipment, now almost completely installed in the laboratory's pilot plant room, will permit work on spray drying and concentration of fruit purees and juices. One piece of equipment is a pilot spray-drying plant. Another is a high-vacuum juice concentrator, with rectifying column for the recovery of volatile flavoring constituents. Work on the design of a deaerator, which can be used to remove dissolved oxygen from fruit juices, is proceeding. Installation of this equipment has been delayed by wartime restrictions.

Yeast from Fruit Wastes. Approximately 40 per cent of the weight of pears is discarded as waste when the fruit is prepared for canning, and the disposal of this waste involves expense and frequently results in pollution of streams. It has been found that the yeast known as Torula yields a product, when grown on modified pear waste, that is comparable to brewers' yeast in B vitamin and protein content. Yields are approximately equal to half the amount of sugar in the waste. Pilot plant studies have been conducted, in collaboration with a cannery, in order to supply operating knowledge and to provide yeast for further evaluation as feed. These studies will be extended as seasonal availability of the raw material permits; laboratory work will be extended also.

Pectin Production and Utilization. Two phases of pectin research are receiving emphasis: (1) development of a simplified method of manufacture to alleviate the current shortage and to reduce present price (85 cents per pound for 100 grade) to levels where pectin can be competitive with industrial colloids such as imported vegetable gums, and (2) development of low-methoxyl pectin products that are useful to the armed forces and that may absorb the increased productive capacity of the pectin industry in the post-war period.

A method for the preparation of low-methoxyl pectin which does not require either concentration of the pectin extract or alcohol in its isolation has been shown feasible through the laboratory stage and holds promise as a means of producing this pectic material at a much lower cost than was formerly considered possible.

Pilot plant study of the continuous production of low-methoxyl pectin has been delayed by inability to procure some of the necessary equipment. It is now expected that trial of the process can be made during the fiscal year 1946. Two gelled fruit products in which low-methoxyl pectin is used as the jellying agent have been developed and submitted to agencies of the armed forces for consideration. One of these, a canned jellied product consisting of 60 per cent fruit and 40 per cent jellied sirup, impressed representatives of the Quartermaster Corps sufficiently that additional developmental work was requested. Recommendations from this laboratory and a commercial concern resulted in the issuance of Quartermaster Corps Tentative Specification C.Q.D. No. 335, "Fruit Dessert: Jellied." A 10-million-can pack was made during the first quarter of 1945 and contracts have been let for processing an additional 12½ million cans during the second quarter. A cold-water pudding mix, which can be made into a palatable and nutritious dessert in five minutes and does not require heating, has been developed and used successfully in trials on hospital trains out of San Francisco.

Tartaric Acid Recovery. An ion-exchange method for the recovery of tartaric acid, developed at this laboratory, has proved satisfactory from the standpoints of yield and quality of product. It was operated on a pilot plant scale during the 1943 season, and about 11,000 pounds were produced. The procedure is now being developed along lines designed to simplify the recovery problem and to reduce the costs of its operation.

Ascorbic Acid from Walnuts - The waste green hulls from Persian (English) walnuts grown in the western area amount to 50,000-60,000 tons annually. About one-half of this quantity is collected at centralized hulling plants. The wet waste hull contains 0.5 to 0.8 per cent of ascorbic acid. Laboratory research on stabilization of the vitamin during extraction and on its isolation, by adsorption, elution, and concentration of the eluate, indicates that a feasible method of preparing the product for the drug and food markets can be devised.

Alfalfa Utilization Investigations:

Studies of Constituents. Extensive research on extraction and stabilization of constituents has shown that technological and economic barriers

to successful industrial development are severe. Laboratory experiments on the practicability of stabilizing carotene in animal and vegetable oils by the addition of edible antioxidants have proved promising; a series of reports on this work has been published. Such research is applicable, however, to carotene derived from sources other than alfalfa. New and improved methods for selectively extracting valuable constituents are being studied; this work demonstrates the intricate nature of the problem and forces the conclusion that successful commercial development must overcome high cost of process as well as competition. Thus the program of research must and will include further surveys and reconsideration of objectives.

Conservation of Valuable Constituents in Alfalfa Meal. The production and use of alfalfa meal, for direct feeding to livestock and for compounding into mixed feeds, has been increasing rapidly. Quality of alfalfa meal varies widely. While most of the meal currently produced consists of ground field-dried hay, increasing use is being made of dehydrated freshly cut alfalfa. The latter type is greener and higher in carotene content than the former. New dehydration plants are being constructed at an accelerating rate, even during wartime. A survey of the alfalfa dehydration industry, which will include its present extent, locations, types, and sizes of plants, and construction and operating costs is being made, to provide a basis for estimates of research needs and potential further expansion of the industry.

Poultry Utilization Investigations:

Dehydration of Whole Eggs. The war stimulated an increase in production of dried whole eggs, from a few million to several hundred million pounds annually. Thus a large industry, with annual capacity to produce $300,000,000 worth of product, has been developed. In this new industry the problem of storage life of the dried product is more critical than any other.

The course of research in this laboratory has been largely toward the finding of the causes of deterioration, through carefully applied analytical procedures. Extensive work has been carried out in an effort to exhaust all possibilities in the search. It seems apparent now that the development of off colors during storage is due to chemical reactions in which pigments, lipids, proteins, and carbohydrates are involved. The more obscure changes responsible for off flavors appear to occur in the lipid fraction. Laboratory methods that extend the shelf life of egg powders have been developed; application to commercial production requires further study. Data on the vapor pressure of water adsorbed by dried eggs have been applied in two designs of commercial spray-drying equipment. This equipment is capable of producing egg powder of very low moisture content and improved keeping qualities.

Lysozyme. Lysozyme is a germ-killing substance that occurs naturally in egg white. At this laboratory a method has been developed whereby substantial amounts of pure lysozyme can be extracted. The large quantities of egg white now lost with the shells in freezing and dehydrating plants can be used as a source of lysozyme. The antibacterial properties and medicinal uses of this product are now being studied in

cooperation with a medical college.

Fibers and Plastics. A group of workers is conducting studies on the production of fibers and plastic materials from waste egg white and poultry feathers (and also materials similar chemically to feathers, such as hair, horn, and hoofs). These workers devote their time to methods of improving experimental fibers, molding powders for plastics, and other experimental substances. Encouraging progress is being made.

Freezing Preservation of Poultry and Poultry Products. Research on freezing preservation of poultry products includes methods for the detection and measurement of deterioration in poultry during the early stages of spoilage, prefreezing treatments of eggs and their relation to quality in the product, pasteurization and slush freezing of mixed eggs, and effect of packaging and storage temperature on quality of cut-up frozen poultry. Recently it has been possible to continue the research only on a small scale, because a large share of the time of research workers ordinarily assigned to frozen poultry has been devoted to work on dehydration.

Vegetable Including Potato Utilization Investigations:

Freezing Preservation. The frozen vegetable industry in the United States packed over 115,000 tons of products in 1944. Twelve years ago practically no vegetables were preserved by freezing. The Western Regional Research Laboratory maintains an extensive research program on freezing preservation of peas, lima beans, snap beans, asparagus, broccoli, tomatoes, and other vegetables. A report of experiments on the freezing of tomatoes and tomato juice was published in 1944. Tomatoes present difficulties; only limited success has been attained thus far and work is being continued. Research on vegetables that are more firmly established in the freezing industry (peas, for example) is concerned particularly with the effects of maturity, variety, locality, and handling methods on final quality. A general discussion of problems related to the freezing of peas was issued in mimeographed form last year; this circular has been published by several food trade journals. The results of studies on methods of determining the amounts of starch and the amounts of crude lipid in vegetables were published during the past year. These studies represent efforts to establish accurate, objective, and convenient methods of measuring maturity in fresh and frozen vegetables of different varieties. Objective tests for quality are highly desirable in a large, growing food industry, because they make it possible to establish standard grades that can be used by producers, processors, wholesale and retail handlers, and consumers. During the past year a substantial amount of new data have been obtained on the effects of variety, locality, and maturity on the quality of frozen peas.

Dehydration. Research on dehydration of vegetables, fruits, and eggs is a major undertaking of the laboratory, with more than a third of the facilities devoted to various phases of that work. Of the three types of commodity, vegetables receive the largest share of attention, and potatoes are by far the most important of the dehydrated vegetables.

Annual requirements of dried potatoes for wartime purposes approximated 80,000 tons in processed weight, which might be conservatively estimated to be worth $70,000,000. Carrots, cabbage, onions, beets, and other vegetables are dehydrated in substantial amounts. Reports from those who use dehydrated vegetables indicate general satisfaction and in some cases enthusiasm for the products.

Dehydrators of white potatoes have faced many difficulties; in fact, potatoes have been perhaps more difficult to dehydrate than any other of the extensively dried vegetables. Laboratory and pilot plant research has, however, contributed much to the solution of such problems as gray discoloration, "popcorn" pieces, reddening and red centers, "sloughing" or mushing during rehydration, and others.

In 1944 the program for addition of sulfiting as a step in the processing of certain dehydrated vegetables was established. Workers collaborated in studies that improved the method of application and also devised and published a method for the determination of sulfur dioxide in dried vegetables. In August, 1944, this Laboratory published a new peroxidase test for dehydrated potatoes, which was adopted as the official test, replacing a test that was less specific.

Comprehensive studies of dehydrated vegetables in storage have gone far toward evaluation of the effect on shelf life of such factors as blanching, sulfiting, loss of soluble constituents through leaching, damage by heat during dehydration, moisture content, atmosphere of storage container, and temperature. The effect of these variables has been measured in terms of flavor, texture, color, vitamin content and other quality factors in the rehydrated products. The most important of the conclusions reached is that moisture content of the product is a factor of great importance. "In-package" dehydration, which can be effected by inclusion of desiccant matter in the sealed can of product, has proved effective as a means of reducing further the moisture content of dehydrated vegetables. This method has been applied successfully to several vegetables, in addition to potatoes.

During the past year studies of the compression of dehydrated vegetables into compact blocks have been carried to the point where methods suitable for commercial use are available.

Basic studies such as those on theory of air-circulation drying, drying characteristics of various types of vegetable pieces, and rehydration, which have been mentioned in previous reports, are being continued.

Culture Medium from Asparagus-butt Juice. During the past several years, work has been continued on the production and use of a culture medium made from the juice of asparagus canning waste. During the 1944 season a substantial quantity of the medium was made in a commercial canning plant - enough to permit tests of its value by microbiological concerns in various places. Laboratory work is being pursued, partially in cooperation with agricultural and medical schools, to determine whether the products of microbiological action have special values in the control of plant and animal diseases. A report has been published

on use of the concentrate in the production of bacterial proteinase, and a report on its value in producing tyrothricin is ready for publication. A mimeographed circular, describing methods of production suitable for use in an asparagus processing plant, has been disseminated and also published by a trade journal.

Oils. Derivatives of fatty acids of vegetable oils, prepared and tested in the Western Regional Research Laboratory, have proved suitable as a plasticizer for coating materials for raincoats. These derivatives have low volatility and low water solubility and contribute the property of flexibility to the coating at low temperatures. A process for the conversion of domestically available saturated fatty acids to derivatives with exceptionally good foaming and wetting properties has been developed on a laboratory scale. Larger equipment, which is being constructed, will supply data on yields and costs and thus on suitability for commercial application.

Use of Propionates to Control Spoilage in Fresh Vegetables. Shelled peas and lima beans were included in tests made in 1944, in cooperation with a commercial vegetable freezing plant, on the effectiveness of treatment with propionate solution in delaying microbial spoilage during the critical period between harvest and processing. This delay period is commonly necessary, because field-vined peas and lima beans must be transported. Thus they are held in a condition in which they are susceptible to spoilage. The tests indicated success in the application of the method. A report of tests on the two vegetables (and also on fruits) will be published by a food journal prior to the beginning of the 1945 harvest season.

Wheat Utilization Investigations:

Gluten Sulfate. The newly developed product called gluten sulfate is receiving attention from interested industrial groups. This product is obtainable from gluten and has the property of absorbing water to the extent of several hundred times its original weight and forming a gel. The method of preparation has recently been improved and cheapened by the substitution of concentrated sulfuric acid for chlorosulfonic acid and pyridine. A soluble byproduct of the reaction involved in the preparation of gluten sulfate has been found to be a foaming agent, which may have industrial value.

Glutamic Acid. The monosodium salt of glutamic acid is a highly valuable derivative of gluten, which is widely used as a food flavoring substance. Two new methods of determining the amounts of this compound in gluten and other proteins have now been developed and published.

Exploratory Studies. A rubber-like product has been developed from gum gluten and glycerol; this interesting product may prove to be applicable, as a gasket material, in places where it will be in contact with oils or hydrocarbons and not with water. Exploratory experiments have suggested that the acid conversion products of low-grade wheat or gluten are powerful inhibitors of acid corrosion of steel, and may offer promise as commercial inhibitors. If the present investigation results in a highly

effective, concentrated inhibitor, this important outlet for low-grade wheat products may be opened. Sheet steel is always "pickled" in hot acid before it is electroplated, tinned, or galvanized, and an inhibitor is necessary to minimize rate of attack. Wheat flour or bran was formerly used but has been displaced by more effective coal-tar derivatives. The new product might prove to be permissible for use in certain canned foods as an anti-corrosion agent.

Hemlock Bark Utilization Investigations:

The bark of the western hemlock is a domestic source of tannin potentially capable of supplying about a third of our national requirement. This source is important because domestic tannin supplies have been reduced by chestnut blight and because foreign sources, chiefly quebracho from Argentina, are regarded as unstable. Development of the western hemlock source of tannin has been hindered by the lack of suitable technology. Ordinary methods of tannin extraction are not suitable and the problem is further complicated by the fact that the logs are floated to the mills and thus lose a portion of their tannin through leaching. The Western Regional Research Laboratory has developed a process for the preparation of a satisfactory tannin extract from the bark of salt-water-floated logs and a report on the study has been published. A manufacturer of western hemlock paper pulp has indicated willingness to undertake commercial development of the process. The probable installation of hydraulic barking equipment at logging and pulping centers located on fresh water makes it highly desirable to investigate also the use of bark from fresh-water-floated logs. This investigation will include a study of preparation of bark, extraction procedure, sulfiting, and other factors influencing yield and quality of tannin from this source.

Work under the project "Hemlock Bark Utilization Investigations" will be closed out in the fiscal year 1946. The main purpose of this project has been accomplished. The closing of this project will release funds needed under the fruit and vegetable investigations projects to secure additional information regarding the nature of deteriorative changes taking place during preprocessed holding, during processing, and storage of the processed product. The new information will serve to guide processing research in food preservation by freezing and by drying.

Eastern Regional Research Laboratory

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated
1. Apple and other fruit utilization investigations a/	$97,560	$119,500	$119,800
2. Vegetable utilization investigations a/	40,200	80,600	80,950
3. Tobacco utilization investigations	175,545	188,600	189,200
4. Milk products utilization investigations	233,970	288,000	288,900
5. Animal fats and oils utilization investigations	186,420	226,100	226,900
6. Potato utilization investigations a/	72,315	88,915	89,190
7. Tanning materials, hides, skins and leather	62,236	77,160	77,325
8. Overtime pay	120,418	16,000	- -
Covered into Treasury as Miscellaneous Receipts, Public Law 529	117	- -	- -
Unobligated balance	26,519	- -	- -
Total available	1,015,300	1,084,875	1,072,265
Anticipated supplemental	- -	-115,035	- -
Total estimate or appropriation	1,015,300	969,840	1,072,265

a/ - Joint project with Western Regional Research Laboratory.

Examples of Progress and Current Program:

Apple Utilization Investigations:

Apple Flavor Concentrate. The Eastern Laboratory's work on apple utilization is largely concerned with the production of apple sirups and apple flavor concentrates. During the past year pilot plant investigations on a continuous method for the recovery of the aroma of fresh apple juice in concentrated form were successfully carried out. The product, apple essence, one gallon of which contains the aroma of 100 to 200 gallons of fresh apple juice, can now be manufactured on a commercial scale. When added to a suitable commercial apple juice concentrate, a full flavor concentrate is produced, which by dilution with water produces a beverage indistinguishable in taste and aroma from fresh apple juice. The cost of producing the essence is estimated at 50 cents a gallon. This includes amortization and all other costs except that of the juice itself which, of course, can still be used in other ways after the essence has been removed.

The essence can be used in the manufacture of apple jelly to convert

it from a product notably lacking in apple flavor to one possessing an agreeable aroma of fresh apples at an increase in cost per pound of jelly of approximately .025 cent. This is on the basis of 50 cents a gallon for the essence. Similarly, the essence cost per pound of apple concentrate amounts to 0.3 cents.

The development of apple essence made it possible to prepare products with enhanced apple flavor characteristics which have been proven by recent industrial surveys and evaluations to be of extensive commercial interest. Among the possible applications for which industrial evaluation tests are in progress are the following: fortification of brandy, mince meat, apple butter, apple sauce, jelly, vinegar, bottled apple juice, table and fountain sirups, bakery products, ice cream, ices, sherberts, and dried, frozen, and canned fruits. Of all the applications of apple essence, its addition to concentrated apple juice for reconstitution to an apple beverage has created the greatest interest.

One large beverage manufacturer has ordered a unit for the commercial production of essences. A large jelly manufacturer has started the installation of an essence recovery unit in which he is planning to process a variety of fruit juices. In addition to these, approximately twenty manufacturers are giving serious consideration to the installation of essence recovery units. There is great interest in the application of the process to other fruits besides apples, especially grapes and oranges.

Further pilot plant development of the apple essence process will be carried out, with emphasis on the preparation of concentrates from specific varieties and combinations of varieties of apples. Continued attention will be given to the establishment of new uses for apple essence in the food and beverage industries.

Apple Sirup. During the 1944-45 apple season the production of bland apple sirup was estimated to be approximately 2,000,000 pounds as compared with the 3,500,000 pounds produced in 1943-44. The decrease can be attributed to the following: 1. Due to the easement of glycerin and sugar for civilian use, bland apple sirup was placed in an unfavorable competitive position. 2. The unfavorable ceiling price of 17 cents per pound for bland apple sirup as compared with 18-1/2 cents per pound for depectinized concentrated apple juice of equivalent concentration. Therefore there was little incentive to manufacture bland apple sirup.

An extensive industrial evaluation of bland apple sirup for use in the baking, confectionery, ice cream, frozen foods, fountain and table sirups, and pharmaceutical industries demonstrated conclusively that bland apple sirup could not compete with the cheaper hygroscopic and sweetening agents. The development of an apple sirup with characteristic apple flavor properties is therefore necessary to maintain and expand the market for this product.

One of the most promising apple table sirups produced thus far is a blend composed of 1/3 depectinized concentrated apple juice, 1/3 invert

sirup and 1/3 corn sirup with 75% of the fresh apple essence from the juice that was used to make the concentrate. Such a product could be produced at about 7 cents per pound from apples at 60 cents per hundred pounds. On the other hand, a table sirup made entirely from apple juice would cost approximately 14 cents a pound using the same grade of apples. This would put the latter product in the cost class of pure maple sirup and would greatly restrict its use. A blend of the type described above, besides being cheap enough to find extensive use, has a better flavor than any table sirup yet produced using apple products exclusively.

Further study is being made of the development of practical means for producing a self-preserving, full-flavored apple concentrate and apple sirup. Factors influencing the development of off-flavors in apple concentrate will be studied intensively.

Vegetable Utilization Investigations:

Processing of Vegetable Wastes. Work on vegetable utilization is dealing largely with the production of high quality foods from vegetable wastes and with their use in feeding poultry. During the past year approximately 3,000 pounds of vegetable leaf meals were produced in pilot plant operations planned to afford further information on commercial utilization of vegetable wastes. The meals, prepared principally from broccoli, lima bean vines, carrot tops, pea vines, beet tops and kale, were used for further feeding trials in cooperation with the Delaware Agricultural Experiment Station. In the course of this work sufficient engineering data were obtained to permit a typical design for a commercial plant suitable for processing leafy vegetable wastes into high-quality leaf meals. A circular describing the method of processing, the equipment required and the costs involved for producing such products from vegetable wastes has been prepared.

In future pilot plant studies, emphasis will be given to the development of continuous methods of drying vegetable leaf wastes.

Vegetable Waste Leaf Meals in Poultry Feeding. Since the initial feed trial carried out in cooperation with the Delaware Experiment Station, five more experiments have been made. Carotene in its natural oil from broccoli was as effective, unit for unit, as fish liver oil Vitamin A. Concentrations of broccoli leaf meal as low as 1½ per cent gave as efficient growth as 5 per cent alfalfa in chick rations. One per cent broccoli supplemented with a small amount of riboflavin gave more efficient growth than 5 per cent alfalfa or a high quality commercial growing mash. Beet leaf meal gave good growth in 2½ per cent concentration in spite of a free oxalic acid content of 11 per cent. Spinach was also excellent in spite of its oxalic acid content of about 4 per cent.

Pea vines were more satisfactory than the product tested originally, but still were not on a par with the others. Dried kale, although efficient in about 1½ per cent concentration, was not as good as broccoli. At a commercial farm, using 700 laying hens, broccoli at 2.5 per cent in a laying mash, comprising half the total diet, gave an average of 54.6 eggs

per bird as compared with 47.4 eggs per bird on 5 per cent alfalfa leaf meal supplemented with addition of vitamin A from fish liver oil.

Studies of the composition of vegetable leaf meal proteins will be continued, with special reference to determination of the essential amino acid contents. These studies are needed for the more complete nutritional evaluation of vegetable leaf meal as animal feeds. Also, chemical studies will be made of the fats of vegetable leaf meals. Particular attention will be given to determination and isolation of the vitamin E present in such meals.

Tobacco Utilization Investigations:

Rutin. Important progress was made during the past year in the further development of rutin production. This substance has been demonstrated to be an effective therapeutic agent in the treatment of diseases associated with capillary fragility and is regarded as of great potential importance in medicine. Due to the relatively high cost and low rutin content (about 0.4 per cent of flue-cured tobacco, investigations were undertaken to discover a more economical plant source. It was found that green buckwheat plants in the early blossoming stage were the most practical source of this material. In order to secure an adequate supply of rutin for further test purposes and to work out a feasible manufacturing procedure, pilot plant scale investigations on rutin production from buckwheat were undertaken. Since most of the rutin is lost if the buckwheat is dried slowly, optimum conditions of artificial drying were first established. In the work during the past season a flash drying and leaf separation technique was successfully employed, the rutin being subsequently extracted from the dried leaf and flower fraction. Seven tons of green buckwheat were so processed, yielding 19 pounds of pure rutin. Based on this work, six large drug companies have indicated their intention to manufacture rutin from buckwheat during the summer of 1945.

During the fiscal year 1946 solvent extraction of rutin directly from green buckwheat will be thoroughly worked out in view of favorable laboratory results, which indicate that such a procedure may be preferable. Further improvements in methods of analysis for rutin are being studied.

Clinical testing of rutin is being conducted in cooperation with the University of Pennsylvania Medical School, and with physicians having the necessary facilities for the use of experimental drugs. There is mounting evidence of the effectiveness of rutin in the prevention of further retinal hemorrhages in patients with hypertension accompanied by capillary fragility. Clinical studies are underway at the University of Pennsylvania Medical School on the use of rutin in phlebitis, coronary thrombosis and X-ray burns.

Further investigation was made on the rutin content of green Pennsylvania cigar filler and flue-cured type tobaccos. The former contained only 0.05 per cent of rutin, while the latter had 0.79 per cent, or about double the average amount in the cured leaf. These studies are being continued.

Fungicide Tests on New Nicotine Compounds. About forty nicotinium salts were prepared and tested for fungicidal value in cooperation with the Rhode Island State Experiment Station, and additional salts are in process of preparation. Lauryl nicotinium bromide, lauryl nicotinium thiocyanate, cotyl nicotinium thiocyanate, lauryl nicotinium propionate, and lauryl nicotinium oleate were the most effective fungicides. Several government agencies and industrial concerns have expressed an interest in these compounds and plans are being made for rather extensive field tests during the fiscal year 1946.

Cooperative field tests of the fungicidal value of nine copper nicotine compounds showed that although three were still effective after 18 days of weathering against the conidia of organisms causing the peach brown rot and apple bitter rot diseases, their use on apple, peach, cherry and plum trees would be rather limited because of plant injury.

Nicotine-DDT Combinations. Tests on mixtures of nicotine with other organic insecticides were conducted in cooperation with the Bureau of Entomology and Plant Quarantine in an attempt to ascertain possible synergistic action from the combinations of toxicants. Small scale laboratory tests indicated a synergistic action in the DDT-nicotine combination. This enhanced toxicity was observed with all forms of the alkaloid employed, i. e. free nicotine, nicotine sulfate, nicotine bentonite, cuprous nicotine cyanide, and the copper nicotinammino derivative of coconut oil fatty acids. It cannot yet be stated with certainty that true synergism, rather than so-called "similar joint action," has been established. Regardless of the type of action involved, however, there appears to be a definite merit in the combination of nicotine and DDT in that the mixture is effective against some insects, such as the European red mite, which are resistant to DDT alone. The mechanism of the effect is undergoing further study.

Milk Products Utilization Investigations:

Casein Bristle Fiber for Paint and other Types of Brushes. Research on milk products falls into two categories: (1) Production of fibers and plastics from casein, and (2) conversion of milk sugar through lactic acid into useful solvents, plasticizers, resins, and synthetic rubber intermediates. Progress reported a year ago in the development of casein bristle has been extended in several directions. Improved machinery for extruding, stretching and hardening the fiber has been devised, and a new satisfactory agent for imbedding the bristle in brushes has been found. Tests performed on brushes containing casein bristle were quite favorable in many respects.

For the commercial production of casein fiber for bristles, it is desirable to use a continuous process rather than a discontinuous one. As a first step in this direction, the piston extruder which is of batch type has been replaced by a continuous screw extruder. The quality of fiber secured is the same, but the screw extruder affords a more convenient method of making air-free fiber and permits a greater production. Other units have been designed for continuous stretching and hardening of the fiber, and it is expected that they can be shortly subjected to trial runs.

The problem of finding suitable materials for imbedding casein bristle in paint brushes has been given considerable attention. It was found that a mixture of urea-formaldehyde and an alkyd resin would harden at 80° C. to give a solvent resistant setting. This material proved particularly satisfactory and has therefore been employed in construction of most of the paint brushes for testing. Casein bristles may be set in rubber, providing the curing temperature is carefully controlled.

Paint brushes made with casein bristle have shown very good characteristics in service tests made by an expert painter. One brush showed little or no wear after more than 100 hours of use on an abrasive plaster surface. The brushes have good paint carrying and spreading capacity, and produce satisfactory films with varnish. Independent tests performed by a brush manufacturing company showed that the casein bristle brush had better paint carrying capacity than a comparable nylon brush, and as good abrasion resistance as natural bristle.

Although the greater part of the casein fiber produced has been used in experimental paint brushes, a number of preliminary trials have been made with casein bristle in other brushes, such as hair brushes, rotary brushes and twisted-in-wire brushes. These brushes on the whole have not thus far proved satisfactory due to breaking of the fiber. This has resulted in part from harsh methods of manufacture, e. g., stapling, and in part from attempts to use short heavy fiber which is less flexible than the long fibers of small diameter. Both of these factors are being further investigated.

The test results on paint brushes made from casein bristle have been so promising that one major brush company is now conducting pilot plant runs of the fiber. Another company has recently secured a license under a pending patent to make the bristle. In cooperation with these companies, a present investigation is directed toward adaptation of the present process to a commercial basis. In addition, the effect on quality of various physical and chemical treatments of the fiber will be investigated, particularly with respect to orientation of the fiber structure and corresponding increase in tensile strength.

Improved Casein Plastics. Investigations are being continued looking to the development of modified casein material with good flow properties which can be directly molded to give satisfactory finished products. Work on the introduction of fatty acid residues into the casein molecule has been extended to higher members of the fatty acid series. Introduction of palmityl, stearyl or oleyl groups into casein markedly curtails water absorption as also had previously been found for the lower fatty acid derivatives. Plastic test pieces molded from the former, however, are superior in strength and toughness. In experiments with casein and cyanate treated casein, both hardened in formaldehyde, it has been found that the addition of plasticizer (sulfonamide type) has a pronounced effect in reducing water absorption. This partial replacement of water by organic plasticizer in the molding powder also substantially improved the dimensional stability of the molded article. The introduction of the plasticizer in amounts up to 8 per cent did not decrease the tensile strength.

Improved Production of Lactic Acid. The importance of lactic acid in the utilization of lactose occurring in whey as well as other fermentable carbohydrates has been mentioned previously. Probably the greatest obstacle to increasing the industrial utilization of lactic acid has been its relatively high cost. The cost of lactic acid (approximately 24 cents per pound for purified acid and 15 cents for crude) is due primarily to difficulties encountered in recovering lactic acid or a suitable derivative from its fermentation liquors, and the fact that lactic acid is manufactured on a relatively small scale (approximately 8,000,000 pounds annually divided among 5 manufacturers).

Work during the past year has shown that the methanol vapor method previously reported is versatile and capable of recovering lactic acid from various crude mixtures such as fermentation liquors, extraction residues, steep-water concentrates, and alkaline degradation products of sugar. Development of this simple and efficient method for obtaining purified L-lactic acid or methyl lactate from different types of crude lactic acid has apparently eliminated the first obstacle to low-cost production. The way is now open for removing the second obstacle by expanding the scale of manufacture. Lactic acid should become one of our cheapest and most useful organic chemicals when its production is increased sufficiently to take full advantage of the economies of large-scale operation.

Solvents and Plasticizers from Lactic Acid. Improved methods for preparing various alkyl lactates other than methyl lactate were developed. Lactates of six commercial alcohols were prepared in good yields either by direct esterification or by ester interchange.

Other lactic acid derivatives which have been prepared and studied for their potential usefulness as solvents and plasticizers include a number of alkyl lactate pelargonates, esters of lactyllactic acid, phenyl and substituted-phenyl acetyl lactates, alkyl alkoxpropionates. A large amount of additional work is contemplated for the proper evaluation of these new compounds.

Many of the compounds prepared from lactic acid have the properties desired in high-boiling solvents and plasticizers, and hence should be suitable for use in the production of cellulose plastics, vinyl rosins, synthetic rubbers and similar products. These lactic acid derivatives thus afford important potential outlets for lactic acid.

Tests made by the Bureau of Entomology and Plant Quarantine have shown that some of the lactic acid derivatives are excellent mosquito repellants. This field also offers a potential outlet for large quantities of lactic acid.

Production of Synthetic Rubber from Lactic Acid. The conversion of saturated acrylic resins into rubbery vulcanizates, designated Lactoprene, was described last year. Although several different methods of vulcanizing monolefinic polymeric acrylic esters were reported, vulcanization was not sufficiently rapid, two or more hours being required for all recipes except that based on benzoyl peroxide. Curing with benzoyl peroxide was rapid, but the products were not so strong as those

obtained with other agents. Development of more rapid vulcanization procedures was undertaken because it is highly advantageous commercially to achieve vulcanization in thirty minutes or less, and it was considered likely that vulcanizates produced in 15 to 30 minutes would have properties different from those made by slow vulcanization. Halogen-containing acrylic polymers were used in seeking rapid vulcanization methods primarily because such polymers can be made readily and vulcanized conveniently by various recipes.

Formulations were developed with which it was possible to effect vulcanization in as short a period as five minutes.

The development of rapid methods for vulcanizing acrylic elastomers (Lactoprene) has increased the usefulness of those rubbery polymers. The evaluation of acrylic elastomers by various Government and industrial laboratories is not complete, but it has been demonstrated already that Lactoprene is outstanding with respect to resistance to oils, oxidation, and aging at normal or elevated temperatures. Its flex life and cut-growth resistance -- even at temperatures as high as 212° F. -- are unusually good. Further evaluation for specialty uses is in progress.

Animal Fats and Oils Utilization Investigations:

High Purity Oleic Acid from Animal Fats and Oils. Research on animal fats and oils is concerned with (1) production of high purity oleic acid, (2) production of useful derivatives of animal fats, and (3) improvement of the stability of lard and foods containing animal fats.

Oleic acid of commerce (red oil) is prepared from animal fats by splitting of the fat to fatty acids and glycerol and subsequent separation of the saturated acids from the unsaturated liquid portion. The resulting red oil may be distilled one or more times, but it will usually contain a total of 25 - 35 per cent saturated and polyunsaturated acids, and for this reason its industrial applications are restricted. A simple process has been developed for the production of high purity oleic acid. It has been found that by selective hydrogenation of a fat or oil, such as animal fats, the polyunsaturated acid content can be reduced readily to 1 per cent or less without substantially affecting the oleic acid content. From this material, oleic acid substantially free from polyunsaturated acids is obtained by either the conventional cold pressing method or by fractional crystallization to precipitate the saturated acids. If it is desirable to prepare oleic acid having a purity above 95 per cent, this can be achieved by fractional distillation for the removal of palmitic acid. These fats which are available cheaply and in large quantity in which the ratio of oleic acid to linoleic acid is high, such as tallows and greases, offer the greatest possibilities for this process. A preliminary market survey made to determine the possible industrial application and trade acceptance of a highly refined oleic acid indicates that there might be a maximum market for approximately 35,000,000 pounds of a purified oleic acid and that it probably would command a premium of 1¢ to 2¢ per pound over the present commercial distilled red oil. Pilot plant scale studies on the process are now underway.

New Compounds from Animal Fats and Oils. At the request of the Navy Department a number of chemicals derived from animal fats and oils were prepared in connection with an important secret aviation use. Preliminary tests indicated that several of these compounds offered so much promise that additional quantities (15 to 25 pounds of each) were made for large-scale testing under combat conditions. The results obtained were excellent and the Navy Department requested that data on the method of making these products be furnished to several private companies for use in the manufacturing of commercial quantities. One of these companies is now furnishing the material to the Navy. Extensive peacetime applications of these products is foreseen.

Improvement of Stability of Lard and Food Products Containing Animal Fats. Investigations on the preparations and use of various substances as antioxidants for fats and oils have been continued and extended. Several new compounds recently synthesized were found to be very effective antioxidants, having appreciable fat solubility. It is believed that studies now in progress will furnish important information on such important subjects as antioxidant "carry over" into baked goods, and possibly on the action of fat antioxidants in foods containing significant amounts of non-fatty constituents. Highly purified preparations of the constituent fatty acids of lard and tallow have been prepared and their oxidative deterioration studied. The polyunsaturated compounds were attacked by oxygen much more readily than the oleic acid which contains only one double bond. The saturated fatty acids were found to absorb oxygen and to produce peroxides and eventually rancid products, although much more slowly than the unsaturated fatty constituents of fats. Antioxidants added to these pure fatty acids and esters decreased the rate of oxygen uptake and peroxide formation, but in general were much more effective with the least unsaturated constituents such as methyl oleate than with the more highly unsaturated esters -- methyl linoleate or methyl linolenate. The data provide a reasonable explanation for the greatly increased stability of selectively hydrogenated vegetable shortening compared with the same oil unhydrogenated. By decreasing the amounts of highly unsaturated acids by hydrogenation, the natural tocopherols present have much greater protective action on the shortening. Active assistance has been given to the Quartermaster Corps, chiefly on evaluation of the wide plastic range shortening materials which have been treated with antioxidants.

Potato Utilization Investigations:

Improved Method for Production of Allyl Starch. Research on potatoes is largely concerned with the production and utilization of potato starch and its derivatives. Continued effort has been directed towards development of allyl starch for use in decorative coatings and laminating materials. Considerable progress has been made in improving the method of preparing allyl starch. Recent experiments have shown that at least three or four times the amount of starch originally used can be allylated with essentially the same amount of reagents as originally used. This materially reduces the cost of producing allyl starch and places it in a more favorable position from the cost standpoint with respect to competitive materials. At least one manufacturer has decided to go into commercial production of allyl starch, and a considerable number of prospective

users of allyl starch are experimenting with it with a view to including it in their formulations. It is of particular importance to the starch industry that a new industrially useful starch derivative such as allyl starch be developed in view of the possible competition with starch of new synthetic chemicals for use in the sizing of textiles. Commercial development of allyl starch would serve as a new industrial outlet for starch and would tend to offset any loss of market due to competition of new sizing chemicals. It is estimated that if the price of a certain one of these sizing chemicals is reduced somewhat it would replace potato starch as a sizing for fine cotton yarns, which is the principal outlet for potato starch at the present time. Pilot plant scale production studies are now underway to adapt the laboratory process for commercial use.

Evaluation of Allyl Starch as a Coating Material. Allyl starch has previously been reported to possess unusual properties which give promise of practical utilization as a lacquer type coating material. In addition to possessing the advantages of rapid drying, oxidative hardening and high solids content, allyl starch is soluble in the less expensive aromatic hydrocarbon solvents. Clear coatings of the material can be immersed in water at room temperature for 24 hours or more without effect on transparency or gloss; they also will tolerate immersion in boiling water for one hour or more without permanent effect. A study of the effect of modifying resins and plasticizers upon the physical properties and curing characteristics of allyl has shown that certain rosins, notably the abiotic acid type, tend to inhibit the curing of allyl starch, while others, such as chlorinated diphenyl, improve flexibility without an inordinate sacrifice of solvent resistance. To summarize, tests show allyl starch to be an unusual coating material unlike any existing commercial product. It dries rapidly by evaporation of solvents and acquires a high degree of resistance to deleterious agents by oxidative hardening in air at room temperature. Other commercial allyl derivatives must be cured at elevated temperatures for optimum hardness. Tests indicate that the unmodified allyl starch will have application as a lacquer. Modifications with resins and plasticizers will be sought to broaden the field of application for the product.

Tanning Materials, Hides, Skins, and Leather Investigations:

New Sources of Domestic Tanning Materials. Studies under this project are concerned with (1) new sources of domestic tanning materials and (2) improved methods for the conservation of hides and skins, and (3) development of improved leather.

Because of the need for new and more extensive domestic sources of vegetable tannins to meet the needs of the leather industry, efforts have been concentrated on development of a number of the more promising domestic sources of tanning materials. The scrub oaks of Florida and adjoining states are being studied as potential sources of bark for making tanning extract. Arrangements are underway for the peeling, gathering and drying of 200 tons of bark for use in preparing experimental lots of extract, which in turn will be used for large-scale heavy leather tanning tests. Preliminary small-scale laboratory tests have shown that satisfactory

liquid and powdered extracts can be prepared from these barks, with good leaching efficiencies. Considerable progress also has been made in studies on canaigre as a source of tannin, particularly on the problem of starch removal before extraction of the tannin. In addition to investigations of these two sources of tannins, progress has been made in continuing studies on development of other domestic sources of tannin, including the following -- pine bark, Western hemlock bark, buttonwood, sumac, and others.

Mold Resistant Treatments for Leather. Work on the development of a mold resistant treatment for carrying cases and other leather ordnance items was completed. After testing various fungicides, solvents, and concentrations of wax, a solution containing salicyl anilide, 2.2 per cent; paraffin wax, 33 per cent; isopropyl alcohol, 25 per cent; and Stoddard solvent, 39-8 per cent, was adopted. Leather items treated with this solution proved highly resistant to attack by molds. They do not absorb water as rapidly as untreated items and do not soften so markedly when wet. Completely fabricated cases can be successfully treated, thus making it possible to give protective treatments to large lots of cases already manufactured. Assistance was rendered to the Ordnance Department in the preparation of directions for the commercial application of the treatment to newly manufactured cases and to those already in use in the field. Tests are underway by the Office of the Surgeon General to determine whether salicyl anilide has any dermatitic effect.

Conservation of Hides and Skins. Investigations have been continued looking toward the better curing, preservation, and utilization of hides and skins. Attention has been directed particularly to the effect of chemicals added to curing salt and to the influence of animal breed upon hide and leather properties. In connection with studies designed to determine the effect of chemicals added to curing salt upon hide preservation and leather quality, it was found that 20 per cent brines, either with or without silicofluoride, gave excellent preservation if 0.1 per cent of paranitrophenol was present. Hide pieces that had been treated with salt solution containing 0.1 per cent paranitrophenol and 0.1 per cent sodium silicofluoride remained soft and flexible when stored under conditions of low humidity, in contrast to hides treated with brines without these added chemicals, which became dry and stiff under the same storage conditions. It appears, therefore, that preservatives added to salt may not only prevent decomposition but may alter appreciably the retained moisture content of stored hides. Studies are being conducted with a number of hides from purebred Hereford and Angus-Shorthorn-Hereford cross-bred steers, all of known life history, to determine the effect of breed of animal on hide and leather-making quality. One side of each hide has been commercially tanned into sole leather. Measurements of area, weight, and thickness of the bond, head, shoulder, and belly portions of these leathers have been made. Other physical and chemical tests will be conducted on these leathers, and the data secured will be used for comparison with similar data to be secured from hides taken from animals of other breeds.

Northern Regional Research Laboratory

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)
1. Agricultural residues investigations	$183,013	$246,700	$248,400
2. Corn, wheat, and other cereal crops utilization investigations a/	522,767	581,935	586,565
3. Soybeans and other oilseed crops utilization investigations	182,977	246,700	248,400
4. Overtime pay	118,583	16,700	- -
Covered into Treasury as Miscellaneous Receipts, Public Law 529	163	- -	- -
Unobligated balance	35,497	- -	- -
Total available	1,043,000	1,092,035	1,083,365
Anticipated supplemental	- -	-122,195	- -
Total estimate or appropriation	1,043,000	969,840	1,083,365

a/ - Joint project with Western Regional Research Laboratory.

Examples of Progress and Current Program:

Agricultural Residues Utilization Investigations:

World War II made heavy inroads into our supply of some of the nonreplenishable raw materials ordinarily used by industry. As a consequence, new raw material sources are needed. Agricultural residues, replenishable annually are virtually an untapped source of raw material which may in part be made to serve this need.

The increase in price of the nonreplenishable materials because of their scarcity, and the development of new processing techniques and products undoubtedly will provide a more feasible basis for the utilization of agricultural residues. The fact that they are replenishable, and that their annual production is of vast proportions, 100 to 200 million tons, may result in their having significant importance in the post-war economy not only in serving industry as a raw material source but also in providing a new source of income to the farmer.

Researches on agricultural residues carried on during the war resulted in the development of a number of distinctive industrial uses of these materials, many of which should have important peacetime uses.

Cellulose Pulps for Critical Board and Paper Products. The production of container and corrugating board for packaging has constituted one of the major emergency problems. Strawboard, made mainly from wheat straw in 28 operating mills to the extent of approximately 500,000 tons per year, represents the highest quality corrugating board material. Due to the lack

of farm equipment and to the shortage of farm labor, the strawboard mills have been hard-pressed for wheat straw. The laboratory has rendered definite assistance to this industry in developing methods for the pulping of soybean stalks, now used to the extent of 50,000 tons per year, barley and rice straws, sugarcane bagasse, and certain wild grasses. In addition this laboratory has supplied factual information concerning methods of preserving and storing such raw materials and has contributed information on problems of collection.

During the fiscal year 1946 continued assistance will be given to the strawboard industry in the improvement of pulping methods. Studies also will be made of the production of cellulose pulps suitable for the fine paper industry.

Continuous Saccharification of Agricultural Residues. Laboratory and pilot laboratory research reported last year on the saccharification of agricultural residues for the production of fermentable sugars and lignin resulted in the development of a process which is now being evaluated on a semi-works scale basis under the authority of Public Law 290 on funds allocated to the Department of Agriculture from the Department of the Interior. In close cooperation with this semi-works evaluation project, further laboratory and pilot plant studies are being carried out on the development of new and improved uses for lignin in plastics and other industrial materials and on the development of new uses and outlets for furfural. Both lignin and furfural are obtained as important byproducts in this new saccharification process.

Insulation Board. Fibrous agricultural residues are particularly well suited for the manufacture of structural insulation building materials. The farm represents an important and established market for insulation board. An important goal of the Regional Laboratories, the development of small rural industries, has been greatly emphasized in post-war thinking. Assuming the ability to make an article of satisfactory quality, three major requirements are evident: (1) The product must find local use and sale on the farm and in the rural community. (2) The plant and process must be of such size and character as to permit the best balance between labor costs and fixed charges to insure profit. (3) Management must be such as to maintain the venture in a healthy condition.

In considering the production of insulation board from agricultural raw materials, three separate processes were studied in order to arrive at the smallest size unit which would appear capable of successful operation. The size decided upon would require a capital investment of approximately $50,000, would employ 11 men, and would consume 1,000 tons of straw per year. Under favorable conditions of raw material supply and trading element, this process should prove successful; in other cases, it would be decidedly marginal or would fail. It would seem particularly adapted for use in countries or territories of low labor costs; such as, for example, in island possessions, in China, and elsewhere.

Studies are going forward on the development of fundamental information on fiber relationships in the use of agricultural residues, particularly wheat straw; in the production not only of insulating building board but also of hard board and such specialties as shotgun wads.

Corn, Wheat, and other Cereal Crops Utilization Investigations:

All cereals are of similar chemical composition. They are composed mainly of starch, protein, and oil. Starch generally constitutes from 50 to 75 per cent, protein from 8 to 20 per cent, and oil from 2 to 5 per cent of the whole kernel. The physical characteristics of the different cereals exert a powerful influence on their uses. In the case of wheat, the doughing characteristics of the protein are responsible for its wide usage as a breadstuff. The cost of the starch, the main constituent in the cereal will be the main factor which will determine the practicability of its use in industry. Thus, for fermentation purposes and for starch production, the cheapest cereal on the basis of its starch content is usually utilized. Under ordinary conditions, this is corn. Barley, on the other hand, because of its saccharifying action on starch, is used primarily for malting purposes. Their fundamental similarity in composition, however, permits the various cereals to be used interchangeably for many purposes.

Work under this project includes studies on the development of new and improved fermentation processes, including penicillin investigations; studies on the development of agricultural motor fuels, including improved processes for the production of alcohol and the development in improved byproduct feeds, and development of new and wider uses for cereal starches and their derivatives and byproducts, including new methods for the separation and recovery of cereal starches and their derived sugars and sirups.

Penicillin. The volume of penicillin industrial production has continued to increase steadily, expanding from 40 billion units in March, 1944, to 460 billion units in March, 1945. As of December, 1945, production is probably in the neighborhood of 750 billion units per month, or enough to treat 750,000 serious cases. This expansion in production has arisen from a combination of better operating conditions and better molds.

As a result of the Bureau's work, better mold strains have been made available to industry, and yields from submerged cultures have been further increased to an appreciable extent. In addition, a new and valuable penicillin-X has been crystallized and studied chemically.

With the final establishment of the penicillin industry on a stable basis and with the solution of many of the difficult and complex technical problems connected with the development of this industry, it is now possible for the staff engaged in research on penicillin to devote increased attention to the development and improvement of other fermentation processes involving the use of cereal crops or other agricultural products as a basis for the production of new and useful industrial materials.

Itaconic Acid. A method for the production of itaconic acid, a new chemical produced by the action of mold growth on dextrose was developed on a laboratory scale. Esters of itaconic acid are of much interest as possible additions to the many methacrylates for the production of transparent plastics. One potential use of the product is in strengthening the lucite resins now used in making bomber "greenhouses."

With the yields so far obtained, it should be possible to produce itaconic acid for 40 to 50 cents a pound in plants equipped for surface culture. If success is attained in current studies to develop a submerged fermentation process, a potential price of 25 cents a pound will assure the wide use of the product.

Starch Sponge. The heretofore little-known starch conversion product, starch sponge, has now been shown to have potential commercial use for the making of food items. It can be used in food products for several purposes. In its dry state, it has a crispness which will impart the property of crunchiness to chocolate candies and to cracker-like wafers.

Fruit or vegetable pulps, vitamins, flavoring extracts, and chocolate can be incorporated into the sponge by addition of the desired ingredient to the paste from which the sponge is made. When shredded, the dry sponge may be used similarly to shredded cocoanut or shredded nut meats. A new type of confection has been made by impregnating intact starch sponge with sweet chocolate. Unlike the use of ground-up puffed cereals, bran, and the like, which are at times added to candies to give them crunchiness, use of starch sponge does not involve the possible irritating action on sensitive intestinal tracts, because the sponge is easily digested in the human alimentary system.

Starch sponge, in addition to having high food value, is an excellent insulating material and has high buoyancy. Starch sponge therefore has obvious possibilities for those uses by the armed forces where these properties are desired and where the insulating or buoyant material could serve as a food under emergency conditions.

Wheat Gluten. The process which the laboratory has developed for separating wheat flour into starch and gluten has received definite industrial acceptance. At least two organizations are using this process for the production of wheat starch as a basis for the manufacture of wheat sirup or alcohol, and are disposing of the gluten for the manufacture of monosodium glutamate. The present demand for monosodium glutamate will diminish; hence, it is important that other uses be found for the gluten portion of the wheat. If this gluten can be dried in such a way that its dough-forming properties are not destroyed, a ready market in the fortification of low-gluten flours may be anticipated. Work is now being conducted with a view to developing a cheap continuous process for drying wheat gluten in such a manner that it may be added to other flours for the production of bakery products. Indications are that a commercially feasible process can be developed.

Riboflavin (Vitamin B_2). Progress has been made in the development of a process for the production of riboflavin by the fermentation of nutrient solutions with a special strain of yeast. Riboflavin is required for the health and well-being of the human as well as for the proper growth and production of farm animals. Methods for the production of this vitamin are of special interest at this time because of the limited supplies of vitamin concentrates available for foods and feeds. Several industrial concerns have shown interest in the laboratory's process, and at least three companies are now carrying on laboratory and pilot plant investigations with the end in view of adapting it to a commercial process.

Preliminary cost estimates indicate that riboflavin can be manufactured by this process for approximately $.08 per gram while the present market price of the chemically-synthesized vitamin is $.18 per gram. It has a further advantage in that the yeast employed produces other essential vitamins which can be recovered with the riboflavin.

Octane Rating of Agricultural Motor Fuels. A survey of octane ratings of agricultural motor fuels has resulted in a mass of information concerning the value of alcohol and other fuels obtainable from agricultural materials. A large variety of blends of alcohol with gasoline and with other products have been examined by engine test methods, and studies of additional blends are in progress. Work is also underway to determine the physical properties of alcohol-gasoline blends.

As a result of these octane determinations, it has been found that iron pentacarbonyl will serve to increase substantially the octane rating of ethyl alcohol. On the other hand, tetraethyl lead causes a reduction in the octane rating of ethyl alcohol. In spite of this fact, alcohol may be blended with leaded gasoline in amounts as high as 15 per cent with results favorable to the octane rating.

Other studies which are being carried forward under this project include the fractionation of starch into its components, production of textile fibers from starch and corn protein, preparation of plastic intermediates from corn sugar, improvement of steeping methods used in the corn wet-milling industry, improvement of methods of grain analysis, utilization of waste "tailings" from the starch manufacturing process, and study of the effect of grain maturity upon starch characteristics.

Soybean and other Oilseed Crops Utilization Investigations:

Specific examples of studies being carried out under this project include (1) investigation of rancidity in soybean oil, (2) liquid-liquid fractionation of soybean and other oils into edible and dry-oil components, (3) catalytic isomerization of soybean and other oils for the production of faster-drying paints and varnishes and flexible, waterproof lacquers, (4) alcoholic extraction of soybean oil, (5) production of plywood adhesives from soybean meal, (6) production and utilization of soybean protein (7) improvement of oilseed analytical methods, and (8) surveys of the oilseed processing industry. Recent accomplishments relating to plywood adhesives, oil conjugation, and fractionation of soybean oil are reported below.

For several years immediately preceding World War II, a serious oversupply of domestic fats and oils developed, which resulted in drastically depressed prices. However, the increased requirements for oils and fats and the interference with the importation of certain oils from abroad, resulting from the war, not only quickly absorbed these surplus stocks but also made necessary marked increases in the domestic production of some of the oilseeds, namely, soybean, linseed, and peanut.

The cutting off of the foreign sources of supply of fats and oils resulted in the substitution of domestic types for certain uses for which they

formerly had been considered neither desirable nor adaptable. Some of these substitutions will undoubtedly cease when restoration of foreign trade again makes available the fats and oils formerly used. The competition of these foreign source materials and the change to peacetime consumption requirements are very likely to result again in an oversupply of certain oilseeds of domestic production, particularly soybeans.

During the war, the utilization studies on vegetable oilseeds were primarily for developing needed substitutes; whereas, now studies on the utilization of oilseeds will be primarily for product and process improvement and for extending the uses in the industrial field.

Although there are certain elemental differences in the chief constituents, oil and protein, of the various oilseeds, these differences are not sufficient to prevent their interchangeability. This interchangeability is facilitated in many instances by chemical or processing modifications evolved through research. Oils are used for food, for lubricants, and in the manufacture of soap, paint, varnishes, linoleum, printer's ink, metal castings and plating, textiles, leather goods, glycerine, explosives, synthetic fibers, hydraulic fluids, molded products, rubber substitutes, et cetera. Proteins are used for fibers, paper coatings, water paints, foaming agents, adhesives, plastics, et cetera. In peacetime, their uses form an important part of our life, and in war, many of them were grim necessities.

Of the oilseeds with which this laboratory is particularly concerned, namely, soybeans, flaxseed, sunflower seed, safflower seed, rapeseed, perilla seed, hempseed, and castor beans, only the first two are at present produced in the United States in quantities large enough to have major industrial significance. Most of the others, or the oil therefrom, are chiefly imported for domestic consumption, as their production in the United States has not proved sufficiently profitable to reach substantial proportions.

Soybean production had a phenomenal increase during the war, increasing from 62 million bushels in 1938 to 193 million bushels in 1944. Factory consumption of the oil constituent of soybeans has increased from 237 million pounds in 1938 to 1,036 million pounds in 1944. This increased consumption has come mainly in foods, and it was caused by an increased demand for food oils coincident with a reduced supply of other edible oils. When the other edible oils become available in increased amounts again, the edible oil industry may reduce the amount of soybean oil used because of its inherent objectionable flavors and odors. Research is being planned to increase the use of soybean oil in the drying oil industries and to maintain, as much as possible, present uses of oil and protein in edible products by preventing the formation of objectionable flavors and odors. In addition, the development of new and improved uses for the oils, proteins, and meal fractions from other oilseeds is a proper function of this intensified research at the laboratory.

Plywood Adhesives. This country annually produces large quantities of soybean and linseed meals which are marketed almost entirely as feed for

livestock, poultry, et cetera. For example, approximately one million tons of linseed cake and meal, and over three million tons of soybean meal were produced in 1943. Only a very small amount of these materials was used industrially.

One of the industrial uses for soybean meal is the preparation of adhesives, which are widely used in soft and hard plywood industries. Plywood bonded with soybean adhesives is considered to be water-resistant but not waterproof. During the wartime emergency, the plywood industry has been required to produce large quantities of waterproof plywood for the aircraft industry. For this purpose the phenolic resins rather than soybean adhesives were used. In 1942-44, the use of phenolic resins in the plywood industry increased from 21 million to 29 million pounds, while the use of soybean adhesives was decreasing from 45 million to 37 million pounds. A method was sought to reduce the unfavorable balance of soybean adhesives and to economize on the use of phenolic resins, which are critical materials. This laboratory has discovered that substantial amounts of the soybean meal, which is a byproduct in the manufacture of soybean protein, can be used as an adhesive with the phenolic resins. One company has actually made use of this discovery and has produced a plywood suitable for aircraft construction and has used 500,000 pounds of soybean meal in its waterproof plywood during a 12-month period from 1944 to 1945. This development served to extend supplies of phenolic resins for adhesives during the war. In the future, it may serve to reduce raw material costs for small houses and other construction.

Conjugated Oils. Although the Northern Region has a large number of oilseed crops which may become important in the drying-oil industry, only linseed and soybean oils have been used to any considerable extent. All of the drying and semi-drying oils which are potential oilseed crops for the Northern Region contain linoleic and linolenic acids as their major constituents. Since these acids are largely responsible for the usefulness of these oils, any method which will increase the content or reactivity of the linoleic and linolenic acids is of great importance. During the past four years, the laboratory has been investigating catalytic methods which will increase the reactivity of the linoleic and linolenic acids in soybean and linseed oils. A catalyst has been found which will improve this reactivity without decomposing the oils, and laboratory studies indicate that it may be feasible to operate with it on a large scale. This process should enable the drying-oil industry to produce oils, comparable to dehydrated castor oil and tung oil, from domestic oils which are available in large quantities.

General Administrative Expenses
(Regional Research Laboratories)

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)
1. General administration	$88,604	$137,440	$137,440
2. Overtime pay	14,881	1,800	- -
Covered into Treasury as miscellaneous receipts, Public Law 529	39	- -	- -
Unobligated balance	28,976	- -	- -
Total available	132,500	139,240	137,440
Anticipated supplemental	- -	-18,600	- -
Total estimate or appropriation	132,500	120,640	137,440

This project provides for the administrative supervision and direction of the work of the four regional research laboratories. Its objects are (a) to develop a well-coordinated research program for the laboratories, (b) to maintain proper control in order to avoid duplication of research activities, and (c) to maintain in Washington centralized control and direction of the business activities necessary for the proper functioning of the organization as a whole.

Frequent conferences have been held with the Directors of the laboratories in order to maintain a well-coordinated, forward-looking research program. For the latter purpose, meetings of the Agricultural Experiment Station Relations Committee have been held at each laboratory, and necessary contacts have been maintained with the Office of the Agricultural Research Administrator and other agencies.

(e) Synthetic Liquid Fuels (Transfer to Agriculture)
(Allotment to Bureau of Agricultural and Industrial Chemistry)

This budget schedule covers obligations under an allotment from the Department of the Interior for the construction and operation of semiworks plant for studies of production of liquid motor fuels from agricultural products.

(f) Special Research Fund, Department of Agriculture
(Allotment to Bureau of Agricultural and Industrial Chemistry)

This budget schedule covers obligations under an allotment for special agricultural chemical researches of a fundamental nature.

(g) Emergency Rubber Project, Department of Agriculture
(Allotment to Bureau of Agricultural and Industrial Chemistry)

This budget schedule covers obligations during 1945 and 1946 under an allotment for investigations to develop new or improved processing methods

for the manufacture of rubber from the rubber-bearing plants guayule and cryptostegia. In view of the pending liquidation of the Project, no obligations are anticipated for this purpose in 1947.

(h) Working Funds, (Bureau of Agricultural and Industrial Chemistry)

This budget schedule covers obligations during 1945 and 1946 under advances, pursuant to Section 601 of the Economy Act of June 30, 1932, for services performed for various agencies as shown in the following statement of obligations under supplemental funds.

STATEMENT OF OBLIGATIONS UNDER SUPPLEMENTAL FUNDS 1/
(1945 and 1946 figures include overtime costs)

Item	Obligations, 1945	Estimated obligations, 1946	Estimated obligations, 1947
Synthetic Liquid Fuels (Transfer to Agriculture): Construction and operation of semiworks plant for studies of production of liquid motor fuels from agricultural products	$140,650	$107,758	$81,768
Special Research Fund, Department of Agriculture: Special research projects (agricultural chemical researches)	80,550	77,528	76,641
Emergency Rubber Project, Department of Agriculture:			
Pilot laboratory investigations on cryptostegia	23,353	- -	- -
Pilot plant investigations on guayule	84,805	63,595	- -
Total, Emergency Rubber Project	108,158	63,595	- -
Working Funds, (Bureau of Agricultural and Industrial Chemistry): Advance from War Department: Investigations on the microbiology of eggs and egg products for the Office of the Quartermaster General of the Army	- -	10,000	- -
War Production Board: Investigations in food compression and packaging of dehydrated compressed food products	3,297	- -	- -

Item	Obligations, 1945	Estimated obligations, 1946	Estimated obligations, 1947
Cooperation with the American Republics (Transfer from State):			
Interne-training for students in chemistry 2/	$3,500	- -	- -
Total, obligations under supplemental funds	436,149	258,881	158,409

1/ Exclusive of Lend-Lease funds which are not included in the regular Budget.

2/ Budget schedule for this item appears in Department of State chapter of the Budget.

PASSENGER-CARRYING VEHICLES

The total estimate of $3,300 for the purchase of passenger-carrying vehicles will permit the purchase of four cars as shown below, three being replacements of units now in possession of the Bureau.

One replacement will be made at the Citrus Products Laboratory, Winter Haven, Fla. The car to be turned in is a 1940 model which will have an approximate mileage of 50,000 miles when traded in. One replacement will be made at the Naval Stores Station, Olustee, Fla. The car to be turned in is a 1940 model which will have an approximate mileage of 70,000 miles when traded in. One replacement will be made at the Eastern Regional Research Laboratory, Wyndmoor, Pa. The car to be turned in is a 1939 model which will have an approximate mileage of 50,000 miles when traded in.

Wartime conditions made it very difficult to obtain adequate repairs to maintain cars in good condition and the rate of depreciation has been, therefore, much more rapid than at normal times when such service is obtainable.

The one additional car to be purchased is for the Eastern Regional Research Laboratory. In the operation of this Laboratory it has been clearly indicated that an additional passenger-carrying vehicle is required. A number of research projects under way, such as that on the utilization of vegetable wastes, require the use of a car for field trips of one or two days duration, while at the same time a vehicle is required at the Laboratory for numerous local trips. It is believed that a station wagon is the most practical type of vehicle to purchase for use on these field trips, since frequently samples are collected which cannot satisfactorily be carried in the ordinary passenger car. Also it will be possible to transport up to five employees and equipment in one vehicle instead of two, thus resulting in a substantial saving in transportation costs.

PENALTY MAIL ESTIMATE
Sec. 2, Public Law 364, 78th Congress
(Allotment to Bureau of Agricultural and Industrial Chemistry)

	1945	1946	1947	Increase (+) or decrease (-), 1947 over 1946
Category 1	$386	$400	$400	- -
Category 2	1,816	2,500	2,600	+$100
Total	2,202	2,900	3,000	+$100

Category 1 consists of the mailing of technical publications of the Bureau furnished in response to specific requests for information relating to its research work.

Category 2 consists of operational and administrative mailings between the Bureau and its regional and field offices to the Department and to private concerns and individuals.

It is estimated that an increase of $100 will be needed for 1947 to properly conduct the regular work of our Laboratory and field stations. During the past fiscal year, very rigid instructions were put into effect by the Bureau in order to assure restrictions of mailings within the available allotment. With the war over and with the return to more normal conditions, especially with the competitive field of materials and supplies considerably enlarged, it is believed that an increase in penalty mail will be necessary in the conduct of the work planned for 1947.

BUREAU OF HUMAN NUTRITION AND HOME ECONOMICS

(a) Salaries and Expenses

Appropriation Act, 1946		$850,000
Anticipated supplemental for additional costs due to the Federal Employees Pay Act of 1945		+73,000
Total anticipated available, 1946		923,000
Budget estimate, 1947		917,000
Change for 1947:		
Overtime decrease	-11,975	
Increase	+5,975	
		-6,000

PROJECT STATEMENT

Project	1945	1946 (estimated)	1947 (estimated)	Increase or decrease
1. Food and nutrition investigations	$228,300	$303,611	$305,583	+$1,972
2. Family economics investigations	129,811	283,338	285,190	+1,852
3. Textiles and clothing investigations	125,046	158,640	159,656	+1,016
4. Housing and household equipment investigations	49,133	110,510	111,227	+717
5. Home economics information	38,982	54,926	55,344	+418
6. Overtime pay	78,802	11,975	- -	-11,975
Covered into Treasury as miscellaneous receipts, Public Law 529	+120	- -	- -	- -
Unobligated balance	146,041	- -	- -	- -
Total available	796,235	923,000	917,000	-6,000 (1)
Transferred to "Salaries and expenses, Office of Information, Department of Agriculture"	+10,395	- -	- -	
Anticipated supplemental	- -	-73,000	- -	
Total estimate or appropriation	806,630	850,000	917,000	

INCREASES OR DECREASES

(1) The net decrease of $6,000 for 1947 consists of the $11,975 decrease for overtime and an increase of $5,975 for placing on a full year basis in 1947 within-grade salary advancements which are estimated to be in effect for only a part of the fiscal year 1946.

CHANGES IN LANGUAGE

The estimates include proposed changes in the language of this item as follows (new language underscored, deleted matter enclosed with brackets):

> Salaries and expenses: For necessary expenses, including not to exceed [$236,184] $300,202 for personal services in the District of Columbia, of the Bureau of Human Nutrition and Home Economics for conducting [, either independently or in cooperation with other agencies,] investigations of the relative utility and economy of agricultural products for food, clothing, and other uses in the home, with special suggestions of plans and methods for the more effective utilization of such products for these purposes, and such economic investigations, including housing and household buying, as have for their purpose the improvement of the rural home, and for disseminating useful information on this subject, [$850,000] $917,000.

It is proposed that the clause "either independently or in cooperation with other agencies," contained in the above-mentioned appropriation item in the 1946 Agricultural Appropriation Act, relating to cooperation in effectuating the purposes for which the appropriation was made, be deleted from the 1947 fiscal year language.

The sole purpose of the proposed deletion of this language from the appropriation is to shorten and simplify the item. The clause proposed for deletion is considered surplusage and, therefore, need not be retained in the annual appropriation act, the cooperative work being authorized by the Act of May 15, 1862 (5 U.S.C. 511), establishing the Department of Agriculture, which was further implemented by the Act of July 24, 1919 (5 U.S.C. 563-564). Elimination of the language from the annual appropriation act will not--in any way--change the scope or character of the work performed under this appropriation item, or the authority of the Department to cooperate with other agencies, institutions, organizations, or others in the conduct of such work.

WORK UNDER THIS APPROPRIATION

Objectives: To determine the kinds and amounts of food, clothing, and other goods and services required in the home for healthful living; to develop methods of using these more efficiently and effectively; and to ascertain facts needed to advise on procedures, programs and policies that would assist families to improve their living levels.

Significance of the Work: Homemaking is the full time job of some 30 to 40 million women. Homemakers spend billions of dollars annually for the goods and services used by the Nation's families. What they get for the money and time they spend has an important impact on the health and well being of the Nation. Their choices largely determine the market for the products of the Nation's agriculture and industry. To help them in their work homemakers and producers are asking for information on family needs and the relative merits and costs of various types of goods and services. This information should be based on research impartially conducted and impartially presented.

General Plan: In the fields of food and nutrition, textiles and clothing, housing, and household equipment, laboratory studies are being conducted to develop information which will help the homemaker in selecting food, clothing and other goods best suited to the purpose, and to assist the family in using these efficiently. Field studies are made to ascertain the kind of living had by various groups of the population and the effect of changes in income, prices and supply upon family living. Wherever practicable, the work of the Bureau is conducted in cooperation with State agricultural experiment stations. Cooperation is also maintained with other bureaus of the Department and other Federal agencies.

Examples of Progress and Current Program: The following examples of recent accomplishments and activities under this appropriation are cited to show progress and efforts on some aspects of the broader problems confronted.

Nutritive value of civilian food supply: Estimates of the nutritive value of the civilian food supply are made periodically as a service to consumers as well as Government agencies concerned with production and distribution of the Nation's food. Studies made early in 1945 indicated that this year the civilian would fare better than in the prewar period, although somewhat less well than in 1944. The improvement for 1945 as compared to 1935-39 is due in part to a 26 percent increase in fluid milk,

providing more protein and a 20 percent increase in calcium. Chiefly because of the larger supply of milk and the enrichment of grain products, the 1945 food supply provided about a fourth more iron and niacin and a third more thiamine and ribolflavin than in 1935-39. Increased consumption of citrus fruit, tomatoes, and green and yellow vegetables in 1945 compared with prewar years provided about 10 percent more vitamin A and 30 percent more ascorbic acid (vitamin C).

Income, food consumption, and dietary adequacy: Various plans are being proposed for assuring more effective postwar food distribution to improve nutrition, to promote full use of agricultural resources, and to provide adequate market outlets. The Bureau has analyzed data on hand and has collected new facts to assist in the Department's study of such proposals, especially as to their possible effects on diets of people in this country and on national demand for various foods.

Analyses of data on hand showed that urban families in 1941 with money incomes of less than $260 per person spent on the average more than half of their income for food. Only when the year's income exceeded $410 per person did the proportion fall below 40 percent. With prices as they were in 1941, the foods suggested in the Bureau's plans for low-cost good diets would have cost more than 40 percent of the income of some 5.4 million urban households, about one-fifth of the urban population. Had these families followed the Bureau's food plans, however, their demand would have increased by 60 percent for tomatoes and citrus fruit and by 30 percent for milk and its products, and for meat, poultry, and fish. Studies are now in progress in a county in Georgia and one in Ohio to find the relation of net money income and farm-furnished food to food purchases and dietary adequacy among farm families.

Family food plans: Family food plans at two cost levels are priced quarterly, using average retail city prices as reported by the Bureau of Labor Statistics. Very little change in cost occurred during the past year. It was estimated that in March 1945 a low-cost nutritionally satisfactory diet for a family of two could have been bought for $7 to $8 a week at average city prices. For a family of four, it would have taken $12 to $13; and for a family of seven, $19 to $22. At a moderate-cost level, corresponding figures were $10 to $12, $16 to $18, and $26 to $29 for families of 2, 4, and 7 persons, respectively.

To help the young married couple, particularly the men and women

now being released from the Armed Services, in setting up housekeeping for the first time, a popular folder called "Food for Two" was issued. This gives a moderate and low-cost food plan with a suggested market list and menus for one week. It shows how the food money may be spent to advantage nutritionally and the table furnished with acceptable meals.

Nutritive value of American foods: New tables giving the composition of 275 common American foods in terms of 11 nutrients have been published. These figures covering protein, fat, carbohydrate, iron, phosphorus, calcium, and five nutritionally important vitamins are the product of painstaking compilation and careful evaluation. Many unpublished data became available through cooperation with the Food and Nutrition Board of the National Research Council. Like the now world-famous tables of food composition published by the Department of Agriculture 50 years ago, these new tables will be the basis for estimating the nutritive value of food eaten in this country and for planning food production and distribution to meet human needs.

Nutritive values of proteins: In war or peace, there is the continuing problem of providing economical sources of high-quality protein. The protein values of wheat germ and corn germ were studied extensively this year, to supplement last year's work on other protein-rich foods of plant origin--soybeans, peanuts, and cottonseed. Wheat germ was found to stand foremost among these plant foods as a source of nutritionally efficient protein. Corn germ, though ranking below wheat germ, was better than the oil seed flours previously studied. However, the quality of the protein in both wheat and corn germ proved inferior to that in egg or milk, especially when used at a 15 percent protein level in an adequate basal diet.

Accurate information on the amino acid content of various foods is necessary for precise appraisal of their protein value. In further search for shortened chemical methods of determining amino acids in proteins and whole foods, a rapid and satisfactory colorimetric procedure for methionine, one of the essential amino acids, has now been developed. By its use methionine determinations have been made on a selected list of plant foods. One interesting discovery was that the Brazil nut contains more methionine than is recorded for any other food. To parallel the new chemical method for methionine, microbiological analysis will be undertaken the coming year, so that values obtained by two methods may be checked in the same laboratory. The use of bacteria for the quantitative determination of amino acids, al-

though still in its infancy, has some advantages over chemical methods; it is more rapid and requires only small quantities of the samples to be analyzed.

Utilization of carotene (provitamin A): Earlier studies by the Bureau had shown that carotene in cooked kale is utilized better by the body than carotene in carrots. Results of current work suggests that this effect may have been due in part to the higher vitamin E content of leaves as compared with roots. The vitamin A value of vegetables determined by feeding experiments with the vegetable itself, often appears to be considerably less than would be expected from a chemical determination of carotene content, however. In cooked kale, for example, the biological value was only about two-thirds of the expected value. But when carotene was extracted from the kale and fed, rather than the kale itself the biological assay gave values which agreed with the chemical assay. This indicates that in kale, at least, incomplete digestion and consequently incomplete absorption of carotene into the body is responsible for the discrepancy noted. These studies indicate that methods of food preparation may greatly affect the utilization of nutrients, even when the latter are not destroyed in cooking, and that chemical methods of analysis must be checked with the more expensive biological methods.

Dried eggs for the postwar market: The future of dried eggs as a staple product for commercial and institutional use or for the home kitchen will depend upon their palatability and keeping quality. Experimental work to improve dried egg quality has been conducted in cooperation with other research agencies. During the past year eggs to which different concentrations of sucrose, lactose, invert sugar and dextrin were added before dehydration were studied for their cooking qualities and palatability before and after storage at 100°F. Initial cooking qualities were retained up to 32 weeks of storage in eggs to which 10 percent lactose had been added and up to 16 weeks in eggs to which 20 percent sucrose had been added, facts which suggest a relatively long life at lower temperatures. Other treatments were less successful. The samples that gave the best results in cooking, i.e. those treated with 10 percent lactose and 20 percent sucrose, showed no change in solubility through 8 weeks storage at 100°F.

An illustrated recipe booklet was prepared to aid in a proposed consumer acceptance test of dried eggs in the retail market. This leaflet gives directions for reconstituting whole dried egg, dried egg yolk, and dried white, and includes about 40 recipes for a wide variety of dishes.

Preparation of foods for home freezing: Home freezing offers another way to extend the egg supply from seasons of abundance to scarcity. Work is under way on types of blending and mixing equipment needed, on substances which may be added to improve foaming property and thickening power, and the kind of containers suitable for freezing eggs with home equipment. The culinary properties of the home-frozen eggs are being studied in foams, sponge cakes, and custards, and flavor changes in scrambled eggs. Objective tests are being developed similar to those used for dried eggs for measuring foam formation, gel strength, and other colloidal properties of egg proteins.

Investigations with home-freezing of fruits and vegetables have now been carried far enough to locate some of the major problems peculiar to different groups of fruits and vegetables. In all foods every effort is directed toward conserving the ascorbic acid (Vitamin C) and flavor throughout a reasonable storage period, since these are important reasons for using fruits and vegetables preserved by freezing. In different foods there are various other problems calling for special consideration. For example, a chief problem with peaches and nectarines is that of darkening in color; with cauliflower, those of flavor and texture; with snap beans and fibrous vegetables, the quality of the fresh product used; and with blueberries and rhubarb, the toughening of skins.

Considerable work has been done on 10 vegetables and fruits that present special problems and preliminary work on five others. The following results with peaches show the value of carefully controlled procedures in obtaining high quality home-frozen products. Packing peaches in 40 percent sugar sirup was found to be more satisfactory than packing in dry sugar for retaining natural flavor and ascorbic acid. To prevent discoloration, five anti-darkening agents were tried. Results after storage showed that of these five pretreatments, those with ascorbic acid and sodium bisulfite were most effective in preventing discoloration. Sodium bisulfite, however, bleached out natural fruit color and left an objectionable flavor. Citric acid was reasonably protective.

Home freezing cabinets: War Production Board records show that by the fall of 1945 some 200 companies had applied for materials for manufacturing home freezing cabinets. Many of these companies are seeking data to help them meet consumer needs. Urban and rural families are likewise asking what construction features they should look for in purchasing this type of home equipment. To help meet the demands of both these groups, the performance characteristics of home freezers are being given intensive study.

While 0°F is known to be a satisfactory storage temperature for maintaining quality of frozen food and economy of operation of equipment, a study made of six home freezers showed a temperature range between the top and bottom of the storage space of from 15° to 35°F. With thermostats set to maintain a temperature of 0°F. at the highest level of refrigerant plates or tubes, a practice now recommended by a number of manufacturers, about 10 percent of the storage space in the cabinets tested was considerably above zero.

No appreciable difference in consumption of electric energy per cubic foot was found in chest-type cabinets when insulation was of approximately the same thickness. About 90 percent of the energy used for cabinet operation under home conditions is required for maintaining storage temperatures, and about 10 percent for freezing and for lowering the air temperature after opening the lids. With temperature of the room at 80°F. the average energy consumption of three cabinets, ranging in capacity from 18 to 24 cubic feet, was 0.223 kilowatt-hour per cubic foot for 24 hours under no-load conditions. Under home use with varying ambient temperature conditions, energy consumption in 24 hours was 0.240 kilowatt-hour per cubic foot.

Studies with five chest-type freezers showed that fully loaded cabinets varied by as much as 36 hours in the time they kept all packages of food below 32°F. after interruption of electric current. The least time was 44 hours. Food in some positions remained below 32°F. 58 hours longer than food in other positions. These facts are important in relation to the speed of action required when electric current is interrupted as in power "outage" or mechanical difficulties with a home freezer.

Utilization of cotton fabrics: Looking to the development of textiles for specific uses, a study comparing various physical properties of cotton fabrics knitted from natural and mercerized carded and combed yarns has been completed. Like woven materials, knitted fabrics were found to be stronger when made from combed than from comparable carded yarns. But contrary to popular belief, it was found that knitted fabrics made from mercerized yarns were weaker than those made from corresponding natural yarns and generally less resistant to abrasion even though the mercerized yarns were as strong as or stronger than the natural. Both the mercerized yarns and the fabric knit from them were less elastic than corresponding natural yarns or the fabrics made from them.

Investigations have been continued on improving single yarns for knit fabrics by means of chemical treatments. Many additive

finishes--those which adhere mechanically to yarns but do not react chemically with cellulose--have been studied. These finishes, including gums, starches, waxes, resins, and glues of various types and in various solvents, have been applied experimentally. Several were found to be effective. For example, hosiery fabrics knit from yarns treated with glue in formaldehyde were improved in appearance, bursting strength, and resistance to abrasion. Some of the acrylate resins improved appearance, elastic properties and resistance to rubbing. Methylcellulose and gelatin with formaldehyde increased elasticity. By using yarns in which the physical properties were improved by a chemical treatment, more satisfactory knit products have been made than was possible with untreated yarns. This work demonstrates ways in which single cotton yarns can be utilized to better advantage.

Serviceability studies on household fabrics: An investigation comparing 33 prewar plain curtain marquisettes, when new and during service, was completed during the past year. Of the all-cotton materials studied, only those made from fine, single yarns were included, since an extensive survey of the market showed that this type predominated among the plain marquisette curtainings available to homemakers. The work showed, in general, that the period of usefulness for most of these marquisettes was comparatively short--2 years or less--and that the amount of shrinkage was high. However, the consumer who prefers cotton marquisettes to other types of cotton glass curtain materials will find that those fabrics made of highly twisted yarns and having many yarns to the inch--at least 50 in the warp and 25 in the filling--will withstand wear better than similar materials having fewer, less tightly twisted, coarser yarns. Of the marquisettes containing rayon in both directions, those having 40 or more continuous filament yarns with considerable twist in the warp and at least 25 like yarns in the filling, wore better than fabrics having fewer warp and filling yarns with little or no twist in the respective directions. Likewise, of the marquisettes having rayon only in the filling, those with continuous filament yarns gave better service than those with a spun rayon filling.

A comparison of two of the most commonly used upholstery materials--cotton tapestry and cotton damaks--showed the former to be the better choice when serviceability is of primary importance. The damasks lost a higher percentage of their breaking strength during abrasion than did the tapestries. A higher number of yarns per inch in an upholstery fabric does not necessarily guarantee satisfactory service, although it may add substantially to the cost of the fabric. Price is an unreliable criterion of wearing quality, the study showed.

Quality of fabrics: Because of the need for consumer information on the relative utility and quality of fabrics currently on the market, samples of staple clothing fabrics from 15 cities of various sizes located in five different regions of the United States have been examined during the past year. This has been accomplished in the Bureau's laboratories and through cooperative projects established with state experiment stations and schools of home economics in Minnesota, Pennsylvania, Tennessee, and Washington. The results of this study of shrinkage, colorfastness, breaking strength and other properties of staple fabrics, the first to be conducted on a Nation-wide basis, are of value in determining the fabric properties necessary in different qualities of staple textile materials, and will be useful in preparing buying guides which, as normal market conditions return, will assist consumers in selecting fabrics well adapted to their needs.

Clothing construction: In research on the relative merits of various kinds of clothing contruction, a machine has been devised by means of which the resistance to abrasion of buttonholes made in different ways can be accurately compared. Progress also has been made in developing a method for testing the comparative durability of different kinds of seams. This work will help in formulating standards for workmanship on clothing, and for garment construction details, which in turn can provide the basis for specifications for clothing of different levels of quality.

Sewing aids have been prepared to help the home dressmaker produce garments of high professional quality. Two bulletins on clothing construction--"Coat Making at Home," "Making a Dress at Home," noted in earlier reports, have been supplemented this year by new publications: "Fitting Dresses," and "Pattern Alteration." New publications on remodeling women's coats and suits and renovating, cutting and reseaming knitted materials for remaking into garments also were issued. These bring to a total of 13 the publications on textile and clothing conservation issued since 1941.

Adjustments of rural families to economic change: A study of the effect of the war on the incomes and the spending and saving practices of white rural families is being carried on in Tennessee in cooperation with the University. This study, the only one of its kind in recent years, provides information from 150 rural nonfarm families in one county, and from 400 farm families in 12 counties. Somewhat more than 60 percent of the latter were owner-operators and about one-quarter were share tenants and share-croppers.

For the year 1944, a time when national income was at a very high level, nearly a fourth of the Tennessee farm families surveyed

reported money incomes under $500, and more than half incomes under $1,000. Six percent reported incomes of $3,000 or more. The median money income was $900. How these Tennessee figures compare with current national data will be known as soon as the Department's report of farm families' gross income and farm expenses for 1945 becomes available from the quarterly survey of Agriculture.

Analyses of spending patterns of the Tennessee group is still in progress. Of interest among the first results are facts about housing. Despite wartime shortages of building materials, 1944 expenditures for housing improvement, repairs, and replacements by Tennessee farm families averaged $35, and thus were about the same as in earlier years among families having the same money incomes. For families with incomes below $1,000, the 1944 Tennessee average was $18; for those with incomes above $2,000, $128. About 10 percent of the families reported expenditures for housing improvements and 22 percent for repairs and replacements. These are about the same percentages as reported for the United States as a whole in 1941.

During the past year data on farm family expenditures for living have been analyzed further to ascertain the effect of family size on patterns of consumption. It was found that farm families in 1941 increased their total expenditures for food but little as number of family members increased, but markedly increased their production of food for home use. In income groups under $1,000, 2- and 3-member families spent more for food and shelter than for other things, but among families with four members, clothing rather than shelter was second in importance. The percentage spent for housing decreased with family size whereas the percentage for clothing increased.

Cooperative work with states: During the fiscal year 1945 cooperative home economics research was initiated under memoranda of understanding with research agencies in 13 states. Since July 1, 1945 this has been broadened to include three other states and plans are now being developed which include 3 additional individual states and one region involving 12 states.

The following tabulation shows the allocations made prior to November 1, 1945, for expenditure in states under memoranda of agreement relating to research on four broad subjects:

Field of Research	1944-45 BHNHE	1944-45 State	1945-46* BHNHE	1945-46* State
Food and nutrition	$16,800	$14,450	$27,450	$22,565
Textiles and clothing	19,100	12,360	22,700	13,685
Housing and household equipment	6,300	3,450	17,450	5,750
Family economic investigations	24,000	546	6,600	2,547
	$66,200	$30,806	$74,200	$44,547

* Further work pending.

In addition $12,000 was spent in 1945 in research on family consumption levels in two states with the informal cooperation of state agencies, and it is anticipated that about $25,000 will be so spent in about 24 states in 1945-46.

Formal or informal cooperation is under way or is now being arranged in the following states: California, Georgia, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Massachusetts, Minnesota, Nebraska, New York, Ohio, Oregon, Pennsylvania, Rhode Island, Tennessee, Texas, and Washington.

Home economics information: The Bureau's research findings are being widely used in the Government's Nation-wide programs dealing with home food preservation, nutrition, use of abundant foods and stretching of those in short supply, and various other problems on the home front. These go out in popular bulletins, press and radio releases, and picture material for print and screen. Last year the Bureau cooperated in the production of a motion picture film for use in the 1944 nutrition program.

Totals of all these informational materials for the year July 1, 1944 to June 30, 1945 are as follows: 20 printed bulletins, 18 processed publications, 26 technical articles for professional journals, 140 popular articles for press or magazine use; 48 radio broadcasts on Nation-wide networks and 8 scripts for syndication and 4 film strips on home food preservation.

(b) Special Research Fund, Department of Agriculture
(Allotment to Bureau of Human Nutrition and Home Economics)

This budget schedule covers obligations under an allotment for special researches in nutrition.

(c) Exportation and Domestic Consumption of Agricultural Commodities
(Allotment to Bureau of Human Nutrition and Home Economics)

This budget schedule covers obligations under an allotment for a study of the utilization of agricultural commodities.

(d) Working Fund (Bureau of Human Nutrition and Home Economics)

This budget schedule covers obligations during fiscal year 1945 under an advance pursuant to Section 601 of the Economy Act of June 30, 1932, for investigations in food compression and in the packaging of dehydrated compressed food products.

STATEMENT OF OBLIGATIONS UNDER SUPPLEMENTAL FUNDS
(1945 and 1946 figures include overtime costs)

Item	Obligations, 1945	Estimated obligations, 1946	Estimated obligations, 1947
Special Research Fund: For special researches in nutrition	$46,150	$50,545	$50,056
Exportation and Domestic Consumption of Agricultural Commodities: For a study of the utilization of agricultural commodities	19,369	- -	- -
Working Fund (Bureau of Human Nutrition and Home Economics): For investigations in food compression and in the packaging of dehydrated compressed food products (Advance from War Production Board)	1,389	- -	- -
TOTAL, OBLIGATIONS UNDER SUPPLEMENTAL FUNDS	66,908	50,545	50,056

PASSENGER-CARRYING VEHICLE

The estimates provide for the purchase of one passenger car which is required to facilitate the work of the Bureau. It would be used to enable personnel to operate more adequately at the sites of various projects operated by the Bureau. At the present time the Bureau's work

is centered chiefly in four buildings--the Center Building, the North Building, and in a textile work shop at the Agricultural Research Center, Beltsville, Md.; and the South Building in Washington. In addition, the cooperative work now carried forward with the Bureau of Plant Industry, Soils, and Agricultural Engineering, Bureau of Dairy Industry, and Bureau of Animal Industry require frequent trips to and from the buildings occupied by these agencies at the Research Center, as well as to and from the main highway where public transportation is available to the South Building, U.S.D.A., Washington, D. C.

At the Agricultural Research Center the distance between the buildings devoted entirely to the work of the Bureau is 1 mile; the distance to the nearest point of public transportation which would give workers access to the work in Washington is 3 miles; the distance to buildings of the Bureau of Plant Industry, Soils, and Agricultural Engineering is 4 miles; and to the South Building, Washington, 17 miles.

The loss of time due to lack of rapid transportation between the various work centers and the slowness of the service in transportation of persons and things among the various parts of the Bureau, between the Bureau and other cooperating agencies, and between the Bureau and the location of mechanical services, has been a considerable handicap to efficient operation.

PENALTY MAIL ESTIMATE
Sec. 2, Public Law 364, 78th Congress
(Allotment to Bureau of Human Nutrition
and Home Economics)

	1945	1946	1947	Increase (+) or Decrease (-) 1947 over 1946
Category 1	$135	$150	$200	+$50
Category 2	1,190	1,348	1,800	+452
Total	1,325	1,498	2,000	+502

Category 1 consists of bulletins, leaflets, and other technical publications describing the results of the research work of the Bureau on problems of family living, nutrition, rural housing, etc., and which are distributed at the direct request of schools, universities, institutions, women's organizations, clubs, private citizens, etc.

Category 2 consists of administrative correspondence and general business operational mailings necessary for the functioning of the Bureau. There is also included in this category considerable correspondence with state colleges and universities which are cooperating with the Bureau in its program.

The increase of $502 for 1947 is needed for mailings and dissemination of information on the research of the Bureau. The number of cooperative projects with state colleges and universities carried on by the Bureau has increased and it is anticipated that they will continue to increase in 1947. As a result the volume of correspondence and the number of technical publications requested will increase. The increase in funds is requested to meet this need.

The Bureau of Human Nutrition and Home Economics has as its major concern increasing the well-being of the nation's families. Through its research and its publications on these problems, the Bureau is giving the homemaker the same kind of scientific help that other branches of the Government are giving the farmer, the manufacturer, the merchant, etc.

The Bureau's research program is directed to serve many groups:

(1) It serves the homes, helping families solve the broad economic problems of family living and the more specific questions involved in the purchase and use of food, clothing, equipment, and other goods and services.

(2) It serves those who produce the raw materials and the finished products used in the home plant, that is, farmers, manufacturers, and also the merchants who sell the products.

(3) It serves the Department of Agriculture. Studies of the adequacy of diets of farm, village, and city families furnish guides to agricultural production and to improved national food consumption habits. Research on textile utilization assists in directing fiber production to meet consumer needs. Programs of land use are strengthened by studies of the use of home-produced food; bases for estimating family income, and for helping families with their farm and home management plans. Other research helps to measure the results of the agricultural program in terms of how farm families live.

(4) Through its research on income and the spending habits of families in cities and villages as well as on farms, it provides many agencies with information basic for formulating a wide range of public policies, such as those relating to taxation, public roads, education, old age security and housing.

(5) It works with the Extension Service and other educational agencies in raising levels of living of farm families through improvement of rural housing and better family spending programs for food, clothing, and household equipment.

Postage is a necessary expense in carrying on the program and objectives indicated above.